John Crawford,
M. D.

by M. Macquer

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A

DICTIONARY

OF

CHEMISTRY.

CONTAINING THE

THEORY and PRACTICE of that SCIENCE:

ITS APPLICATION TO

NATURAL PHILOSOPHY, NATURAL HISTORY, MEDICINE, AND ANIMAL ECONOMY:

WITH

Full Explanations of the QUALITIES and MODES of ACTION of
CHEMICAL REMEDIES:

AND THE

FUNDAMENTAL PRINCIPLES

OF THE

ARTS, TRADES, and MANUFACTURES,
DEPENDENT ON CHEMISTRY.

TRANSLATED FROM THE FRENCH.

WITH

NOTES, ADDITIONS, and PLATES.

THE SECOND EDITION.

TO WHICH IS ADDED, AS

AN APPENDIX,

A

TREATISE on the Various Kinds of PERMANENTLY
ELASTIC FLUIDS, or GASES.

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Crawford

A PREFACE

BY THE

TRANSLATOR.

THE name of the Author of the French Dictionary, of which this Work is a Tranſlation, is not prefixed to it; nevertheleſs, it has been univerſally attributed to Mr. MACQUER, Profeſſor of Medicine and Chemiſtry in the Univerſity of Paris, and Member of the Royal Academy of Sciences, who has very juſtly acquired amongſt Chemiſts a diſtinguiſhed reputation. Whoever compares the ſtile and doctrines of this writer, in the works to which his name is prefixed, with thoſe of the preſent Dictionary, will not heſitate to give his aſſent to the general opinion concerning the author.

The Work itſelf is not by any means unworthy of Mr. MACQUER. It contains a very extenſive knowledge of chemical hiſtory, facts, and opinions, and exact deſcriptions of the operations and inſtruments of chemiſtry. The Phenomena of Chemiſtry are well and fully explained, ſo far as the preſent ſtate of chemical knowledge admits. The author has farther rendered his Work of very extenſive utility, as well as curioſity, by the applications which he has made of Chemiſtry to Natural Hiſtory, Medicine, Pharmacy, Metallurgy, and all the numerous arts and trades, the operations of which depend on chemical principles. In this comprehenſive plan is included whatever relates to Chemiſtry; and I believe we may juſtly affirm, that this Dictionary contains more chemical knowledge than any one book extant.

Some perſons may perhaps diſapprove of treating Chemiſtry in an alphabetical order. The Author himſelf ſays in an Advertiſement prefixed to this Work, " that notwithſtanding the opinion of ſome " learned perſons who adviſed him to compile a " Chemical Dictionary, he had been doubtful of the " propriety of that diſpoſition; but that, upon far" ther reflection, it appeared to him leſs exception" able, and even to be attended with ſome peculiar " advantages."

We muſt acknowledge that the form of a Dictionary is a very imperfect one for teaching a ſcience, or " knowledge of the relations of certain things to " each other." But the Chemiſtry which is now known is ſcarcely entitled to the name of ſcience, ſo defined. It is at preſent little more than a collection of facts, the cauſes of which, and their relations to each other, are ſo imperfectly underſtood, that it is not yet very capable either of the ſynthetic or analytic modes of explanation. Among the advantages attending an alphabetical diſpoſition, the Author mentions, that many articles have been inſerted in the Dictionary, which could not have been introduced in any other method. Hence we may certainly infer, that the connexion of theſe with the other parts of Chemiſtry was not perceptible, and conſequently that Chemiſtry is incapable of a more ſyſtematical arrangement. In this ſtate of knowledge, no kind of book ſeems to be more deſirable than a Dictionary with references to connected articles, in which the ſeveral parts of Chemiſtry are treated ſeparately, and ſo diſpoſed, that any article, concerning which information may be wanted, may be eaſily found, and in which every thing relating to Chemiſtry may be inſerted.

When our knowledge ſhall be greatly extended, a more perfect arrangement may be admitted. And now, ſince Chemiſtry is delivered from the obſcure jargon of alchemiſts, and from the narrow limits of one profeſſion, namely, the medical, from which it has received much of its advancement; ſince it is now juſtly conſidered as one of the moſt important branches of natural philoſophy; ſince it has become a more general object of ſtudy, and has lately been ſucceſsfully cultivated at home, but eſpecially abroad, by perſons who employ the advantages attending rank, opulence, leiſure, and philoſophical minds, to the acquiſition of knowledge, and improvement of uſeful arts; we may hope, that the number of chemical facts may be daily encreaſed; that thoſe diſcovered may be farther aſcertained and illuſtrated; and that ſome perſon of eminently perſpicuous genius may unfold the laws and cauſes of chemical combination and analyſis, collect and methodize the ſcattered facts, and form the ſeveral parts of Chemiſtry into one regular, connected ſcience.

The merit of the original Dictionary is ſufficiently evinced by the very favourable reception it has met with, and the high eſtimation in which it is held, by Chemiſts in all parts of Europe. But in a ſubject perhaps too extenſive for the labours of One Man, ſeveral articles have been omitted which deſerve a place in a work that has ſo ample a title as the preſent. Some of theſe I have endeavoured to ſupply by additional Notes. But the moſt material defect ariſes from the Author not having been acquainted, at the time of publication, with ſome late diſcoveries concerning thoſe permanently elaſtic fluids, called *Factitious* or *Fixable Airs*, or *Gaſes*, which have been made by Dr. *Black*, Dr. *Macbride*, and Mr. *Cavendiſh*, and which have thrown much light on a great many chemical phenomena. This deficiency I endeavoured to ſupply, in the firſt Edition, by adding an article on *Fixable Air*, and ſeveral occaſional notes. But ſince the publication of that edition, this branch of experimental Philoſophy has been ſo ſucceſsfully cultivated by Dr. *Prieſtley*, M. *Lavoiſier*, and others, that I found myſelf obliged to reviſe the ſubject, and to make large additions. I have accordingly now ſubjoined, as an Appendix, *A Treatiſe on the various kinds of permanently elaſtic Fluids, or Gaſes*; in which I have collected and digeſted all the principal obſervations and diſcoveries which have been made concerning theſe fluids. And I hope this will not be an unacceptable part of the preſent Publication; as no attempt has been hitherto made to arrange all the knowledge we have acquired on this curious and important ſubject, which at this time engages the attention of Philoſophers in many parts of Europe.

A knowledge of the forms of chemical inſtruments being eſſentially neceſſary, and not being capable of being well communicated merely by deſcriptions, *Plates* are therefore added to this Tranſlation.

Thus I have endeavoured to render the Dictionary of Chemiſtry more extenſively uſeful than it is even in the excellent original. If I have attained this purpoſe, I hope that theſe volumes may be conſidered as a Work, from which *Students of Chemiſtry* may be taught the ſeveral parts of this uſeful Science; *Naturaliſts* may acquire a knowledge of the properties of thoſe bodies which they are ſo curious to diſcover, and to diſtinguiſh; perſons occupied in the numerous *Arts* and *Manufactures* dependent on Chemiſtry, may learn the principles on which their ſeveral operations are founded, and be thereby enabled to improve and extend them; and laſtly, from which, as from a Repoſitory of Chemical Knowledge, *Philoſophical Chemiſts* may collect the facts and opinions already publiſhed, and thence may be aſſiſted to conduct their experiments, and to form their reaſonings for the farther advancement of Chemiſtry.

ADVERTISEMENT.

MANY good Treatiſes have been publiſhed on Chemiſtry, ſince that Science has been cultivated as a fundamental and eſſential part of Natural Philoſophy. But none of theſe publications have the form of a Dictionary. Such a work, however, has been thought ſo deſirable by ſome men of learning and taſte for Chemical ſtudies, that they have adviſed me to undertake it. I confeſs, that at firſt I did not much approve of their propoſal, as I thought that the connexion and mutual dependance of the parts of Chemiſtry rendered this ſcience incapable of being treated with propriety in an alphabetical order. But on further conſideration, and as I advanced in the execution of the work, I perceived that the form of a Dictionary was leſs imperfect, and even much more advantageous, than it ſeems to ſome men of learning.

The alphabetical arrangement does indeed ſeem to interrupt and diſconcert the regularity of plan and ſyſtem, with which a ſcience ought to be treated. But this fault may be remedied (as indeed it is in this work, and other good Dictionaries of Sciences already publiſhed) by references to correſponding articles; and the connexion may, by this means, be reſtored. Beſides,

ſides, this apparent want of order allows the readers to form ſuch plans to themſelves as they may judge proper; and they may poſſibly make a better choice than the Author would have done.

Another advantage attends the treating of a ſcience in an alphabetical order. Names of a great number of things occur under their reſpective initial letters, which would be omitted, in any other method: and thus the ſcience is rendered in many reſpects more compleat and extenſive.

I have only to add, that the readers of this work will eaſily perceive, that it is not a mere vocabulary, or dictionary of definitions; but rather a number of diſſertations, generally full and extenſive, on all the important objects of Chemiſtry, written with a deſign to accompliſh all thoſe intentions propoſed in the title-page.

A
PRELIMINARY DISCOURSE
CONCERNING THE
ORIGIN AND PROGRESS
OF
CHEMISTRY.

AS the Hiſtory of any Science ought to relate the labours, the diſcoveries, and the errors of the cultivators of that Science; and to ſhew the obſtacles which they have been obliged to ſurmount, and the miſtaken paths into which they have ſometimes been miſled; it cannot therefore fail of being very uſeful to perſons engaged in the ſame purſuits. This conſideration has induced us to give the following abridged Hiſtory of Chemiſtry. But that we may not repeat what ſome excellent authors have already copiouſly and accurately delivered, we ſhall here treat no further concerning the particular Hiſtory of Chemiſts, than as it tends to illuſtrate the general Hiſtory of Chemiſtry. Our intention is, to ſhew the ſeveral ſtates in which this Science has appeared; the revolutions it has undergone, and the circumſtances which have favoured or retarded its progreſs; in a word, we mean to diſplay a ſummary picture or repreſentation of Chemiſtry in different periods, from its origin to the preſent time.

Moſt authors who have written Hiſtories of Chemiſtry, have deduced its origin from the higheſt antiquity.

tiquity. They extend their reſearches into the firſt ages of the world, and pretend to diſcover antediluvian chemiſts. But, like all the hiſtorians who have attempted to penetrate through the obſcurity of theſe remote ages, they have found nothing but fable, prodigy, and uncertainty.

We do not now live in thoſe ages of credulity, when it could be with gravity maintained, and ſupported by the authority of apocryphal books, that angels and demons, ſmitten with love of women, diſcloſed to them the ſublimeſt parts of Sciences, and the profoundeſt ſecrets of Chemiſtry; that the book containing theſe ſecrets was called *Kema*, from which Chemiſtry derived its name; beſides a thouſand other reveries of the ſame kind with the preceding, which are not worthy to be mentioned (*a*) All that can be truly and reaſonably ſaid on this ſubject, is, that the invention of ſeveral arts which depend on Chemiſtry, and are moſt neceſſary to men, is of the moſt remote antiquity. The Sacred Scriptures mention that *Tubal-cain*, who lived before the Flood, made inſtruments of copper, and of iron. This Tubal-cain is believed to be the ſame perſon whom the Heathen Mythology afterwards admitted amongſt the gods by the name of *Vulcan*.

Theſe hiſtorical traces have made *Tubal-cain* be generally conſidered as the firſt chemiſt: a title, which ought to be granted to him with reſpect to that kind of Chemiſtry only which is practiſed, not as a ſcience, but as an art, or a trade.

(*a*) The author of *A Courſe of Chemiſtry*, who follows the principles of *Newton* and of *Stahl*, and is the firſt of our writers who have conſidered this Science in a manner truly philoſophical, has ridiculed with as much wit as juſtice theſe abſurdities, in an hiſtorical diſcourſe prefixed to his work; where the elegance of the ſtile is ſuitable to the importance which this learned author has given to his ſubject. [*Note of the Author.*]

No doubts will remain on this point, if we reflect on the nature and progreſs of the human mind. For, what we call Science is the ſtudy and knowledge of the relations which ſubſiſt betwixt certain facts, which neceſſarily muſt be ſuppoſed to have been previouſly diſcovered. But the diſcovery of theſe facts muſt have been effected merely by the deſire of gratifying the ſenſes. For the moſt active and penetrating mind could have done little, in compariſon with the internal perception of a craving want, which muſt be obeyed. If it had not been for the pleaſing and painful impreſſions excited in us by ſurrounding objects, we ſhould have remained ignorant of their moſt common properties. Chance at firſt diſcovered ſome of theſe properties; and ſelf-love, from which ariſes an inſtinct more clear-ſighted than reaſon itſelf, applied them to uſe. The firſt men therefore being neceſſitous, muſt for that reaſon have been the firſt artiſts. They ſeized on the beginnings of the arts by a natural effort, very different from that improved reaſoning, which alone can give birth to Science, and which requires the ſpace of ſeveral ſucceeding ages for its formation and perfection. We may then conclude that the patriarch *Tubal-cain* did no better deſerve the name of *Chemiſt*, than our founders and blackſmiths. This concluſion is conformable with the text of Scripture, where he is called only, *malleator* and *faber*; which is to ſay, that he was no more than a mere artiſt, as all thoſe primeval men were, who acquired more knowledge than their cotemporaries.

The idea which we here give of the original inventors of arts ought not to diminiſh the glory due to them. For, as the human underſtanding was then in its infancy, and as the Sciences did not yet exiſt, theſe inventors did all which they could poſſibly do. Although they were ſimple and rude workmen, yet they ought to be regarded as the greateſt geniuſes of their age. For the ſtrength and extent of the underſtanding of men are leſs the work of nature, than of the time and of the country where chance has placed them. If *Stahl* had lived before the Deluge, all the effort of that genius which unfolded the myſteries of nature by means of the moſt ſublime Chemiſtry, would probably have been reduced to invent the method of forging an ax; and alſo the great *Newton*, who could meaſure the univerſe, and calculate infinites, might perhaps have exhauſted the whole force of his mind in reckoning ſo far as the number ten, if he had been born among thoſe American nations whoſe beſt arithmeticians cannot exceed three. Let me therefore repeat it; the firſt perſon who forged iron, or caſt braſs, although leſs expert than our meaneſt artiſts, was notwithſtanding a great man, and no leſs deſerving our eulogiums than the moſt ſkilful and profound Chemiſt.

It has happened to Chemiſtry, as to the other arts. Before the invention of letters, an apprentice could only practiſe what he had learnt from his maſter by oral tradition; and he in the ſame manner tranſmitted his knowledge to his ſucceſſor, like our preſent workmen, who write nothing, although the art of writing has been ſo long known. The moſt excellent art of writing was, like moſt others, diſcovered by the ancient Egyptians; and to this happy era may be truly referred the increaſe of human knowledge, and the birth of Science. Then, a real diſtinction appeared betwixt philoſophers and artiſts. The latter proceeded in an uniform courſe, and confined themſelves to practice; whereas the former carefully collected all the knowledge which could extend or adorn the human mind, made it the object of their reſearches, encreaſed it by meditation and reaſoning, reduced it by writing into order, communicated it to each other, and, in a word, laid the foundation of philoſophy. Theſe illuſtrious men were the prieſts and the kings of a people who had wiſdom enough to reſpect, and were therefore worthy to be governed by, ſuch maſters.

Amongſt theſe royal philoſophers, *Siphoas* is conſidered by Chemiſts as the founder of their Science. He lived, as it is believed, more than 1900 years before the Chriſtian era. The Greeks, who received the Sciences from the Egyptians, knew him by the name of *Hermes*, or *Mercurius Triſmegiſtus*. So numerous is the liſt recorded by Clemens Alexandrinus of this ancient philoſopher's works, (none of which remain) that, in his time, conſiderable progreſs muſt have been made in the Sciences. Yet among all that liſt not one treatiſe is profeſſedly written on Chemiſtry, although we find ſome on every other Science, excepting that one, which has received from him the name of *Hermetic Philoſophy*. In the library at Leyden ſome Arabian manuſcripts, ſaid to have been written by Hermes, are more directly on the ſubject of Chemiſtry. Such, for inſtance, as that manuſcript concerning poiſons and antidotes, and another concerning precious ſtones. But theſe compoſitions are juſtly conſidered as ſpurious, and leſs ancient. *(b)* Probably, therefore, all the

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(b) Two illuſtrious Egyptians of the name of *Hermes* are recorded by ancient authors. The elder, who is ſuppoſed to be the ſame as *Mizraim*, the grandſon of Noah, the *Hermes* of the Greeks, and the *Mercury* of the Romans, is conſidered as the founder of the Sciences. And the younger *Hermes*, ſurnamed *Triſmegiſtus*, who lived a thouſand years afterwards, reſtored the Sciences, after they had fallen into oblivion in conſequence of a great inundation of the Nile. Of his numerous works none remains, excepting perhaps the Smaragdine Table. No leſs than thirty-ſix thouſand books are ſaid to have been written under the name of Hermes. But all theſe are not to be attributed to him. For, according to Jamblichus, a cuſtom prevailed of ſubſcribing all

the Chemiſtry known in the time of *Hermes* conſiſted of detached pieces of knowledge, the relations of which were undiſcovered, and which therefore could not form a Science; although, at that time, Aſtronomy, Ethics, and ſome other Sciences had made conſiderable progreſs, as is evinced by the enumeration of the books of *Hermes*. We ſhall be leſs ſurprized at this obſervation, when we conder that ſome of the moſt important phenomena of Chemiſtry are very little obvious to our ſenſes. Hidden as they are by nature under a veil, like the ſprings of ſome precious machine, they are diſcoverable by thoſe only who know to ſearch for them, and by eyes exerciſed in that ſearch. If ſome of theſe ſingular and remarkable phenomena have been ever diſcovered by accident, they could only appear to theſe early philoſophers as detached facts, the application and uſes of which could not be perceived, becauſe many other facts, eſſentially related to thoſe diſcovered, were unknown.

Theſe firſt Chemiſts, therefore, had no other reſource than to collect the phenomena which came within their knowledge. Theſe they might reproduce at pleaſure, either for uſe, or to excite the aſtoniſhment of the ignorant.

Such, without doubt, was the Chemiſtry of the firſt inventors of the Sciences; and ſuch was the Chemiſtry which was taught to *Moſes*, "inſtructed," as the Scriptures ſay, "in the wiſdom of the Egyptians;" and which was afterwards taught to *Democritus*, who went to Egypt on purpoſe to learn

all books of Science with the name of Hermes. Some of theſe are preſerved in great libraries; and a book, entitled, *The Works of Hermes*, was publiſhed at Venice, in Greek and Latin, 1531, and at Cologne, 1620, with notes by Annibal Roſellius. Some authors deny the exiſtence of Hermes, and maintain that his hiſtory is allegorical. *See Deſlande's Hiſtoire Critique de la Philoſophie*, Tom. I. Livre I. ch. 6.

the Sciences at their place of origin. Both of theſe have been numbered among Chemiſts: the former, becauſe he diſſolved the golden calf, and rendered it potable by the Iſraelites: the latter, from the teſtimony of many ancient authors, and particularly of Pliny the Naturaliſt, who aſcribes to Democritus a knowledge alſo of the magic arts. (c)

Although we have advanced but little in the Hiſtory of Chemiſtry, we cannot proceed without mentioning a ſingular madneſs which poſſeſſed Chemiſts. It was a kind of epidemic malady, the ſymptoms of which ſhewed to what exceſs of folly the human mind could proceed, when influenced by a ſtrong prepoſſeſſion. It excited chemiſts to ſurpriſing efforts, by which admirable diſcoveries were made; but it nevertheleſs impeded the advancement of Chemiſtry. Finally, the time when this malady began to be cured, which was not ſooner than the laſt century, is the true era of the revival of this Science, and of its progreſs to perfection.

It is evident, that I mean the paſſion for making gold. From the time that this metal has become, by general convention, the repreſentative of the value of all commodities, it has kindled a freſh fire in the furnaces of Chemiſts. It appeared natural enough that men ſkilled in the properties of metals, and accuſtomed to ſee them take a thouſand various forms, ſhould endeavour to produce the moſt beautiful and the moſt precious of all theſe metals. The wonders which they every day ſaw ariſe from their art, made them conceive hopes of adding this new prodigy to thoſe which they had already effected. They were at that time far from being capable of judging concerning the poſſibility of their undertaking; ſince even now that queſtion is undecided. To blame their firſt trials would be therefore unjuſt. But unfortunately this new object of their reſearches, was but too capable of producing a ſtate of mind very different from the philoſophical: it ſo engroſſed their attention, that they loſt ſight of other objects: they imagined that to be the ultimate end and perfection of Chemiſtry, which in reality was only the ſolution of one chemical problem: their Science, far from being more extenſive, was concentrated round a ſingle point; to accompliſh which they directed their labors. The deſire of gain became their motive of action: they were cloſe and myſterious: in a word, they had the character of tradeſmen; and if they had ſucceeded, they would have been mere makers of gold, inſtead of being intelligent and ſkilful Chemiſts. But, unfortunately for them, the trade at which they labored exiſted only in their imaginations. This circumſtance, however, by which they were deprived of a conſtant gain, diſtinguiſhed them from other artiſts, and rendered their ſituation ſomewhat ſimilar to men of ſcience. They therefore availed themſelves of this ſimilarity, and arrogated the titles of Philoſophers and of Chemiſts, in preference to all others; as is expreſſed by the Arabic particle *al*, which they added to the name of their ſcience; whence the words Alchemy and Alchemiſt, ſignifying *The* Chemiſtry, and *The* Chemiſt.

(c) Of all the Greeks who travelled into Egypt to acquire knowledge, *Democritus* only was admitted into their myſteries. None of theſe writings are preſerved. The Egyptian prieſts are ſaid to have taught him many chemical operations; amongſt which were the the arts of ſoftening ivory, of vitrifying flints, and of imitating precious ſtones. *Ol. Borrich. Senec. Epiſt.* 30.

Theſe men were therefore an intermediate ſpecies between philoſophers and artiſts. They had the name of the former, the character of the latter, and were indeed neither the one nor the other. In order to ſupport their reputation, they wrote books, like the philoſophers, on their pretended ſcience:

but as character is never to be effaced, they wrote theſe books ſo obſcurely and unintelligibly, that they gave no more inſtruction concerning their art than if they had not written. Several of them ſeem ſenſible of the reproach to which they are juſtly ſubject in this reſpect, and endeavour to excite attention by declaring at the beginning of their books, that they mean to ſpeak clearly and plainly; which, however, they take care not to do. It is ſomething ſingular to ſee them, after having formally promiſed to reveal the moſt hidden ſecrets, expreſs themſelves more obſcurely than any of their predeceſſors.

We may eaſily judge what conſideration theſe people were held in, who did nothing, and taught nothing: hence their hiſtory is as obſcure and confuſed as their writings. We do not even know the true names of moſt of them, the time when they lived, or whether the books attributed to them be genuine or ſpurious. In a word, every thing concerning them is involved in myſtery.

We ſhall not then enter into a detail about *Syneſius*, *Zoſimus*, *Adfar*, *Morienus*, *Calid*, *Arnoldus de Villa Nova*, *Raymond Lully*, *Alanus Lillius*, *Johannes Mennius*, and numberleſs writers, or pretended philoſophers, the enumeration of whoſe names would be tedious: but we ſhall haſten over this middle age of Chemiſtry, which is the moſt obſcure and the moſt humiliating part of its hiſtory. Thoſe who are deſirous of knowing what is related concerning the Chemiſtry of theſe times, true or falſe, may conſult the works of Borrichius, and the *Hiſtory of the Hermetic Philoſophy* by the Abbé Langlet de Freſnoy.

We ſhall content ourſelves with obſerving, that in this crowd of alchemical and unintelligible writers, there are a few who have expreſſed themſelves leſs obſcurely on certain experiments, and have given ſome intelligence. Such perhaps are *Geber*, the Arabian; *Roger Bacon*, an Engliſh Monk, who appears to have known gun-powder, and who was accuſed of magic; *Raymond Lully*, *Baſil Valentine*, and *Iſaacus Hollandus*, in whoſe writings ſomething may be decyphered concerning acid ſpirits, antimony, and perhaps other ſubſtances.

Theſe valuable hints, which lie ſmothered under a heap of riddles, are ſufficient to make us regret, that theſe laborious ſearchers into the philoſopher's ſtone have neglected to inform us of other pieces of knowledge, becauſe they were not immediately related to their object of inquiry. The moſt eſſential ſervice which they could have rendered to Chemiſtry was, to relate their unſucceſsful experiments as clearly, as they have obſcurely related thoſe which they pretend to have been ſucceſsful.

Such was the ſtate of Chemiſtry, or rather of Alchemy, till the ſixteenth century. At that period, a famous Alchemiſt, called *Paracelſus*, a man of quick parts, extravagant, and impetuous, added a new ſpecies of folly to the follies of his predeceſſors. Being the ſon of a phyſician, and himſelf a phyſician, he imagined, that by Alchemy an *univerſal medicine* might be diſcovered. While he was boaſting, that he poſſeſſed the ſecret of prolonging his life to the age of Methuſalem, he died at the age of only forty-eight years. Before him indeed *Raymond Lully*, and other Alchemiſts, had dreamed of an univerſal medicine; but this famous chimera owed its credit chiefly to the eagerneſs and confidence of Paracelſus.

This notion, abſurd as it was, gained many partiſans, and gave double force to the madneſs of Alchemiſts; ſo apt are men to believe what they wiſh to be true! Our philoſophers, without laying aſide their former inquiries into the tranſmutation of metals, and the making of gold, vied with each other in eagerneſs to diſcover the univerſal remedy; and perſuaded themſelves, that theſe ſeveral miracles might be effected by one chemical proceſs. Many of them boaſted that their attempts had ſucceeded, and ſtiled themſelves *Adepts*. Their books were now filled with receipts for making potable gold, elixirs of life, panaceas or univerſal remedies; but were written in their uſual, that is to ſay, unintelligible language.

So many accumulated extravagancies had rendered Chemiſtry a pretended ſcience, or, as M. Fontenelle ingeniouſly ſays, "a little truth was ſo "diluted in a large quantity of falſhood, that it "became inviſible and inſeparable. To the few "known properties of ſubſtances their imaginations "added others more dazzling. Metals were ſup"poſed to ſympathiſe with planets, and with the "principal parts of the human body: an alkaheſt, "or menſtruum, which had never been ſeen, was "ſuppoſed to be capable of diſſolving all ſub"ſtances: the greateſt abſurdities were reverenced, "becauſe they were enveloped in myſterious dark"neſs, in which they were entrenched againſt the "attacks of reaſon."

The notion of an univerſal remedy, although the moſt fooliſh that had entered the heads of Alchemiſts, was however the cauſe of the eſtabliſhment of rational Chemiſtry on the ruins of Alchemy.

The fiery and enterpriſing *Paracelſus* had ventured to ſtrike out a new road in the art of healing. He declaimed inceſſantly againſt the ancient pharmacy, in which were few or no Chemical remedies; and in a fit of madneſs he publickly burnt the writings of the ancient Greek and Arabian phyſicians; vaunting, at the ſame time, that by his Chemical preparations he could beſtow immortality. His ſucceſs, although inferior to his promiſes, was however prodigious. He made many ſurpriſing cures; and he applied, with great advantage, mercurial preparations againſt the venereal diſeaſe, which appeared about that time, and baffled the remedies of ordinary pharmacy.

The real merit of Paracelſus excited many envious enemies; and the enthuſiaſm and fooliſh vanity with which he blazoned his ſkill, excited the admiration of others ſtill more fooliſh.

Thoſe phyſicians who had good ſenſe enough to avoid theſe extremes, took the middle and wiſeſt part. They were perſuaded, that much dependance was not to be given to the ſayings of a man who was fooliſh enough to deſpiſe the knowledge of all others, and to continually boaſt of his own diſcoveries, and therefore would not, like the mad partiſans of Paracelſus, give implicit faith to his extravagant aſſertions. But, on the other ſide, they were convinced by his ſucceſsful cures, that Chemiſtry could furniſh excellent remedies, unknown before that time; and, like good citizens, they endeavoured to diſcover thoſe remedies by an induſtry worthy of praiſe, ſince their motive was the good of mankind. They were, to ſpeak properly, the inventors of a new Chemical art, the object of which was the preparation of medicines. They wrote what they knew concerning their art, becauſe they were not mere artiſts; and they wrote clearly, becauſe they were not Alchemiſts.

There were then two claſſes of Chemiſts, very different from each other.

While the *Roſicruſian fraternity*, *Coſmopolitanus*, *Eſpagnet*, *Beauſoleil*, *Philalethes*, and many others, loſt their time, their trouble, and their money, in proſecuting the fooliſh notions of *Paracelſus*; many valuable works were publiſhed by *Crollius*, *Quercetanus*, *Beguinus*, *Hartmannus*, *Vigani*, *Schroder*, *Zwelfer*,

fer, *Tachenius*, *Le Fevre*, *Glaſer*, *Lemeri*, *Le Mort*, *Ludovicus*, and many others, who applied themſelves to diſcover and deſcribe new Chemical remedies.

The principal Faculties of Medicine, perceiving how important it was that remedies ſhould always be prepared in one uniform manner, endeavoured to fix and eſtabliſh the proceſſes: hence the many *Pharmacopeias* and *Diſpenſatories*, in which many excellent Chemical operations are deſcribed.

The greateſt part of thoſe *Chemical arts* which are exerciſed without literary ſtudy, had, in the days of Paracelſus, arrived to a remarkable perfection, by a progreſs, ſlow indeed, but long, and uninterrupted from almoſt the beginning of the world. *Ores* of *metals* were then advantageouſly eſſayed and ſmelted. The methods were well known of allaying, diſſolving, and refining *metals* for the purpoſes of goldſmiths and of coinage. The compoſition of *glaſſes*, of *factitious cryſtals*, of *enamels*, and of various kinds of *earthen-ware*, was underſtood. The preparation of *colors*, and their application to the purpoſes of dying, were known. *Fermentations*, by which *wine*, *beer*, and *vinegar*, were produced; and *diſtillations*, by which the ſpirituous, volatile, and aromatic parts of plants were procured for the compoſition of *eſſences* and *perfumes*, were underſtood and practiſed: but all theſe arts were exerciſed by people who knew nothing but what related to their own buſineſs; and as they had never been deſcribed, ſo they were not all underſtood by any one perſon. All the parts of Chemiſtry did then exiſt, but the Science of Chemiſtry did not yet exiſt.

Happily the taſte for knowledge, which then began to ſucceed the jargon and ignorance of the preceding ages, awakened men of a philoſophic mind, and made them ſenſible how important it was to acquire and publiſh ſuch a number of uſeful facts. They ſurmounted all kinds of obſtacles, in order to diſcover and unravel the operations of workmen, who, though not Chemiſts, exerciſed the moſt eſſential parts of Chemiſtry.

The celebrated *Agricola* is one of the firſt and beſt authors of this kind. Born in a village of Miſnia, a country abounding in mines and metallurgic works, he has deſcribed them exactly and copiouſly. He was a phyſician, and cotemporary with Paracelſus, but of a character very different. His writings were as clear and inſtructive as thoſe of Paracelſus are obſcure and uſeleſs. *Lazard*, *Erker*, *Schinder*, *Schlutter (d)*, *Henkel (e)*, and ſome others, have alſo written on metallurgy, and have deſcribed the art of eſſaying metals. *Antony Neri*, Doctor *Merret*, and the famous *Kunkel (f)*, who has enriched Chemiſtry with many fine experiments, have deſcribed very fully the arts of making glaſs, enamels, imitations of precious ſtones, and ſeveral other things.

The valuable Chemiſts whom we have mentioned, and even many who ſucceeded them, and whom we diſtinguiſh from the Alchemiſts, were not however entirely free from the illuſions of Alchemy. So true it is, that an obſtinate and inveterate malady never diſappears at once, without leaving traces behind. Thus, ſince the time of Paracelſus and Agricola, we have had many authors, in ſome reſpects rational Chemiſts, and in others Alchemiſts. *Keyſler*, *Caſſius*,

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(d) The works of *Schlutter* have been tranſlated into French by *Hellet*, and enriched by the obſervations of the Tranſlator, to whom Chemiſtry has many obligations.

(e) A part of *Henkel*'s works have been tranſlated into French by the *Baron d'Olbach*, one of the moſt zealous and illuſtrious benefactors of French Chemiſtry.

(f) The works of *Neri*, *Merret*, and *Kunkel*, are tranſlated into French by *Baron d'Olbach*.

Roeſchius, *Orſchal*, *Sir Kenelm Digby*, *Libavius*, *Van Helmont*, *Starkey*, *Borrichius*, are of this number. But they have ſufficiently made compenſation for this fault by the number of intereſting experiments which they have related.

As in the latter times of the Authors above-mentioned, the Alchemical phrenzy began to draw near its criſis, it was attacked by many powerful antagoniſts, to whom rational Chemiſtry has many obligations; ſince by their writings, they contributed to reſcue that ſcience from an evil which at once diſgraced it, and retarded its progreſs. Amongſt theſe authors, are moſt diſtinguiſhed the celebrated *Kircher*, a Jeſuit, and the learned phyſician *Conringius*, who wrote with much ſucceſs and reputation.

We are at length arrived at one of the moſt brilliant eras of Chemiſtry: I mean the time when its ſeveral parts began to be collected, examined, and compared by men of genius ſufficiently extenſive and profound to comprehend them all, to diſcover their principles, to obſerve their relations, to unite them into one body of rational doctrine, and to lay the true foundation of Chemiſtry, conſidered as a Science.

Before the middle of the laſt age, this edifice was not begun to be erected, but the materials only had been collected. *James Barner*, phyſician to the King of Poland, was one of the firſt who arranged into order the principal Chemical experiments, and added rational explanations. His work is entitled *Philoſophical Chemiſtry*. All the phenomena of this Science are there referred to the ſyſtem of acids and alkalis which *Tachenius* had eſtabliſhed, but which he had abuſed by extending too far: a fault very pardonable, when we conſider how difficult it was for him to avoid it, who had diſcovered truths ſo general and ſo fertile in conſequences as are the properties of theſe ſubſtances.

Bohnius, a Profeſſor at Leipſic, publiſhed alſo a valuable Treatiſe of Rational Chemiſtry; but the reputation of theſe Philoſophical Chemiſts has been almoſt eclipſed by the famous *Becher*, Principal Phyſician to the Electors of Mentz and of Bavaria. This man, whoſe genius equalled his knowledge, appears to have ſeen, with a ſingle glance, the immenſe multitude of chemical phenomena. By reflecting on theſe important objects, he invented the beſt and moſt ſatisfactory theory which has been ever publiſhed. This theory has had the honor of being adopted and commented upon by the greateſt and moſt ſublime of all the Philoſophical Chemiſts.

By theſe titles the illuſtrious *Stahl*, Principal Phyſician to the late King of Pruſſia, deſerves to be diſtinguiſhed. Born, as *Becher* was, with a ſtrong paſſion for Chemiſtry, which ſhewed itſelf in his early youth, he inherited a genius ſtill ſuperior to that of *Becher*. His imagination was as lively, as brilliant, and as active as that of his predeceſſor; and he had, beſides, the ineſtimable advantage of being regulated by that philoſophic and temperate wiſdom, which effectually preſerves from enthuſiaſm and illuſion. The theory of *Becher*, which he has adopted almoſt entirely, has become, in his writings, of all theories the moſt enlightening, and the moſt conformable with the phenomena of Chemiſtry. Very different from thoſe ſyſtems which are produced by imagination, without truth, and which experience deſtroys, the theory of *Stahl* is the ſureſt guide that we can take for our conduct in Chemical reſearches; and the numerous experiments which are every day made, far from invalidating it, become new proofs for its confirmation.

Next to *Stahl* we place the immortal *Boerhaave*; though he excelled in a different way. This powerful genius; the honor of his country, of his profeſſion, and of his age, threw light upon every ſubject which he treated. To the view which he took of Chemiſtry we owe the fineſt and moſt methodical analyſis of the vegetable kingdom; his admirable Treatiſes on Air, on Water, on Earth, and particularly that on Fire, which is an aſtoniſhing maſter-piece, ſo complete, that the human underſtanding can ſcarcely make any addition to it.

Although the theories of the great men we have mentioned may contribute infinitely to the advancement of Chemiſtry, by explaining the cauſes and relations of the phenomena of that Science; we muſt however confeſs, that they may produce a very contrary effect, if we deliver ourſelves up to them with too much confidence, and extend their application beyond their true limits. Theories can only be uſeful ſo far as they ariſe from experiments already made, or lead us to new ones; for reaſoning may be conſidered as the eye of a philoſopher, but experience is his feeling; and this latter ſenſe ought conſtantly to rectify the too frequent errors of the former. If experiments, undirected by theory, are only a blind feeling; theory without experiments is a deceitful and uncertain viſion. Accordingly, the moſt important diſcoveries that have been made in chemiſtry, have been owing to the joint aſſiſtance of both.

A very convincing proof of this truth appears in the works of the illuſtrious literary Societies, whoſe origin may be conſidered as the origin of experimental philoſophy, and the true era of the expulſion of the barbarous jargon of the Schools, of the illuſions of judicial Aſtrology, of the extravagancies of Alchemy, which were only chimerical ſpeculations, deſtitute of proof, or confuſed heaps of incluſive facts.

The learned and profound Memoirs of thoſe celebrated Societies will be ever the model of thoſe who intend to advance the progreſs of Science; ſince there we always ſee experiments giving ſtability to theory, and theory giving light to experiment.

We have now the advantage of ſeeing the beſt days of Chemiſtry. The taſte of our age for philoſophical matters; the protection of Princes; the zeal of a multitude of illuſtrious and intelligent perſons attached by inclination to the ſtudy of this Science; the profound ſkill and ardor of modern Chemiſts, whom we do not attempt to praiſe, becauſe they are above our eulogiums; ſeem all together to promiſe the moſt brilliant ſucceſs. We have ſeen Chemiſtry drawing its origin from neceſſity, and receiving a ſlow and obſcure encreaſe from avarice. To true philoſophy it was reſerved to bring it to perfection.

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ABSORBENT. (a)
ACETOUS. (b)
ACESCENT.

This word may be employed to denote a matter, which either is turning ſour, that is to ſay, acid, or which is ſlightly acid. *See* ACID. (c)

ACID. Acids are of all ſaline ſubſtances the moſt ſimple, and conſequently ought to be conſidered as *ſecondary principles*. Their name is derived from their taſte, which is acid or ſour. One of the marks by which they are eaſily known, is their property of changing into red the blue colors of an infuſion of flowers of violets, or of the tincture of heliotropium. *(d)*

(a) ABSORBENT. Thoſe *earths* are called *abſorbent*, which are capable of being combined with acids. Theſe are calcareous earths, aſhes of burnt vegetable and animal ſubſtances, magneſia, and earth of alum. This claſs of earths might be more properly denominated *alkaline earths*. *See* EARTH, MAGNESIA, ALUM.

(b) ACETOUS. *Acetous acid* is the ſame as vinegar. *Acetous fermentation* is that fermentation by which vinegar is produced. *Acetous ether* is an ether made by means of vinegar. *See* VINEGAR, and ETHER.

(c) The word *aceſcent* can only be properly applied to denote the firſt of theſe meanings. The ſecond may be expreſſed by either of the words, *acidulous* or *ſubacid*.

If acids were ſeparated from all moiſture or water, and from all other ſubſtances not neceſſary to their ſaline eſſence,

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(d) Acids generally change the blue color of vegetables, eſpecially of their flowers, and of their infuſions, to a red; and they heighten the red color of theſe ſubſtances; whereas alkalis change the blue colors of vegetables to a green. Hence the ſyrup of violets, the tincture of heliotropium, and other infuſions of vegetables, have been generally uſed to diſtinguiſh the acid or alkaline qualities of bodies. This criterion is, however, ſubject to many exceptions. The volatile ſulphureous acid whitens blue and red flowers. Several neutral ſalts have been obſerved to act upon theſe colors. Alum is ſaid by ſome authors to render ſyrup of violets red; and by others, green. The difference may have ariſen from the exceſs of alkali employed in the preparation of alum; for it is known that a lixivium of aluminous earth cannot be well cryſtallized without addition of ſome alkaline ley. The Count de Saluces has even obſerved, that the color of ſyrup of violets was at firſt rendered purple by means of alum, and that it afterwards became green. A ſingular exception to the above general rule is furniſhed by the *lignum nephriticum*; the blue color of an infuſion of which is converted by acids to a yellow, and is again reſtored by an alkali.

The Count de Saluces has, in the *Turin Memoirs*, publiſhed an account of experiments made to diſcover the cauſe of the changes of color induced on ſyrup of violets by mixture with different ſubſtances. From theſe experiments, he found that a green color was given to the ſyrup by the following ſubſtances, moſt of which are conſidered as neutraliſed; *Vitriolated tartar*, *Glauber's ſalt*, *vitriol of copper*, *calcined bones*, *nitre*, *ſea ſalt*, *ſugar of lead*, *turpeth mineral*, *calcined gypſum*: that a red color was given to the ſyrup by *ſpirit of vitriol*, *marine acid*, and *cream of tartar*: that *aqua fortis* produced a golden-yellow color: that *alum* produced a violet color, which afterwards changed to a dirty green: that *artificial plume-alum* gave a cherry-color: and that the color of the ſyrup was rendered firſt green, and afterwards of an orange-yellow by *oil of tartar*, and by *quicklime*, and by *volatile alkali*. He infers from theſe facts, that the redneſs given to ſyrup of violets proves a ſuper-abundance of acid in the ſubſtance which produces that color; but that the green color is a very equivocal proof of the preſence of an alkali, and rather indicates ſome neutral ſubſtance, if the green color be permanent; for if any matter be added in which a fixed or volatile alkali predominates, the green color, which at firſt appears, is afterwards changed to a yellow.

they would appear under a concrete or ſolid form. But generally they are liquid; becauſe their affinity to water is ſo great, that when they contain no more than what is neceſſary to conſtitute them ſalts, they are ſtrongly diſpoſed to ſeize more water, whenever they can touch it; and as the atmoſphere is always loaded with watery vapors, the contact of the air is ſolely ſufficient to render acids fluid, by their rapid union with its moiſture.

Acids have a general tendency to unite with almoſt all ſubſtances, particularly with thoſe which are either ſimple, or not much compounded; as phlogiſton, alkaline ſalts, fixed and volatile earths, (eſpecially thoſe called *abſorbent)*, metallic ſubſtances, water, and oil.

Many ſubſtances are by chemiſts called *acids*, becauſe they poſſeſs thoſe general properties which we have mentioned. But theſe ſubſtances differ from each other by properties peculiar to each.

As acids from their tendency to unite, and to remain united with almoſt all other bodies, are never found ſingle and pure, but muſt be obtained and ſeparated by artificial operations from the bodies with which they happen to be combined; they have been diſtinguiſhed by authors into claſſes, according to the ſubſtances whence they are extracted. Theſe claſſes are *mineral acids*, *vegetable acids*, and *animal acids*. In Mr. Geoffroy's Table of Affinities, thoſe of acids are marked in the following order: fixed alkali; volatile alkali; earths; metallic ſubſtances. *(e)*

Very

(e) Under the article AFFINITY are ſubjoined two *Tables of Affinities*, one by *Geoffroy*, and the other by *Gellert*, together with an explanation of them. Here it may be neceſſary to mention, in order to the underſtanding of the text, that thoſe ſubſtances are placed firſt in order which have the ſtrongeſt affinity, that is, which are moſt diſpoſed to unite with the ſubſtance whoſe affinities are compared together. Thus, according to Mr. Geoffroy's Table, quoted in the text, acids are more diſpoſed to unite with fixed alkali than with volatile alkali, earths, or metallic ſubſtances; and more diſpoſed to unite with volatile alkali, than with earths and metallic ſubſtances; and laſtly, are more diſpoſed to unite with earths than with metallic ſubſtances.

The *affinities of acids*, that is, their *comparative powers of union with other ſubſtances*, are in the following order, beginning with the greateſt. 1. Fixed alkali. 2. Calcareous earth. 3. Volatile alkali, and magneſia, the affinities of which to acids

are

Very concentrated acids taken internally in a doſe ſomewhat large; for inſtance, an ounce, or even much leſs, when the acid is ſuſceptible of great concentration; are corroſive and genuine poiſons. Their beſt antidotes are alkaline ſubſtances, either ſaline or earthy, oils, alkaline ſoaps, large quantities of mild drink, as water, milk, mucilages. Theſe muſt be given copiouſly and ſpeedily.

Small doſes of acids diluted with much water, ſo as to be agreeably acidulous, and blunted by ſome mild ſubſtance, as ſugar, are excellent cooling and aperitive medicines, fit to quench exceſſive thirſt, and leſſen the acrimony of the bile. They are chiefly uſeful in alkaleſcent diſpoſitions, and in putrid, inflammatory fevers. Their whole action ſeems to be exerted on the primæ viæ; for they are rendered unactive by the powers of digeſtion, by means of which they are combined with the earthy and oily parts of aliments and digeſtive juices. They would be certain poiſons if they paſſed into the blood-veſſels with their acid qualities, at leaſt with their acidity undiminiſhed. They would coagulate the blood, and would greatly irritate the nervous and ſenſible parts. Malpighi killed a dog by injecting into the veins ſuch a quantity of nitrous acid, as would not have hurt if it had been ſwallowed. Acids employed externally ſhew ſimilar qualities, but more ſenſibly than when impaired by the digeſtive powers. They are uſeful againſt alkaleſcent putridity. *(f)*

ACID

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are nearly equal. 4. Iron, zinc, copper, and perhaps ſome other metals. 5. Earth of alum. 6. The remaining metals.

(f) I. The *common properties of acids* are, 1. They may be united with water. This is not merely a dilution of acids, for by uniting concentrated acids with water, heat is produced; and the mixed fluid acquires a ſpecific gravity, different from the intermediate gravity of its component parts. From this union, therefore, a new compound is formed. 2. Concentrated acids produce cold, when mixed with ice. The vitriolic acid has been ſaid by ſome authors to produce heat by mixture with ice. But the heat thus excited has been occaſioned by too great a quantity of vitriolic acid in proportion to the ice. For a certain proportion of that acid being added to ice, thaws the ice, and produces cold, like the other acids: But if more vitriolic acid be added to the ice thus thawed, it will have the ſame effect, which, as we have obſerved, is occaſioned by the adding of this acid to water; that is, heat will be produced. 3. They may be combined with ſpirit of wine. *See* ETHER.

4. They

ACID (ACETOUS). *See* VINEGAR.

ACIDS (ANIMAL). This name is given to acids obtained from certain animal matters; as butter, fat, blood, ants, and moſt flies.

Theſe acids have been too little examined to enable us to judge whether they be eſſentially different from thoſe obtained

4. They may be combined with abſorbent earths. 5. They may be combined with alkalis. 6. They may be combined with metallic ſubſtances. Although every acid does not directly diſſolve every metallic ſubſtance, yet probably by concentration or dilution of the acid, diviſion of the metals by mechanical and chemical methods, by application of ſufficient heat, and other means, every metal may be acted upon by every acid. 7. When much concentrated, they may be combined with phlogiſton, and with oils. 8. When they combine with theſe ſubſtances, they diſengage from them all or part of the fixable air which they contain. 9. They ſoften and diſſolve the ſolid parts of animals. 10. They coagulate moſt of the liquid parts of animals. 11. They change to red the blue, and heighten the red colors of vegetables, excepting volatile ſulphureous acid, which deſtroys theſe colors. Probably this change of color proceeds from the action of acids upon the oily parts of vegetables; for oils are rendered red by acids ſufficiently concentrated. 12. They reſiſt fermentations. 13. They are not capable of being frozen by ſo ſmall a degree of cold as water is.

II. As acids ſo powerfully attract water, that they are never found pure and dry, but always in a fluid ſtate, when uncombined with earths, alkalies, or metals, we cannot eaſily aſcertain the quantity of acid contained in acid liquors. Homberg has attempted to eſtimate the quantity of acid contained in the acid ſpirits of vinegar, nitre, ſea-ſalt, and of vitriol, by combining theſe liquors with ſalt of tartar, ſo as to form neutral ſalts, imagining that the weight gained by that alkali from its union with acids, or the difference betwixt the weight of the ſalt of tartar and the neutral ſalt produced, was equal to the weight of real acid contained in the quantity of acid liquor employed. But as he did not conſider, that the gas expelled from ſalt of tartar, during its combination with acids, makes a very conſiderable part of the weight of that alkali, the inferences from his experiments are not juſt; and the real quantity of acid contained in an acid liquor, is ſo much more than the quantity inferred by him, as the whole weight of the gas diſengaged from the ſalt of tartar. The quantity of gas contained in ſalt of tartar varies much according to the method of its preparation, and other circumſtances; and the quantity alſo of water retained obtained from vegetables. But we are certain, that they differ in the ſame circumſtances as the vegetable acids do from mineral acids; and probably, this difference proceeds from the ſame cauſe which conſtitutes the difference betwixt the vegetable and mineral acids; namely, the combination of oily particles with the former. (g)

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retained by different neutral ſalts in their cryſtallization, being very different, we may eaſily perceive another ſource of error in the eſtimate made by M. Homberg.

III. The *known acids* are, 1. Vitriolic acid. 2. Nitrous acid. 3. Marine acid. 4. Acetous acid. 5. Vinous acid, or tartar. 6. Eſſential acid of vegetables. 7. Acid obtained by diſtillation of vegetables. 8. Acid of bitumens. 9. Acid of borax. 10. Acid obtained by diſtillation of oils, reſins, and fats. 11. Phoſphoric acid. 12. Acid of ants and other inſects. 13. Acids of healthy and of diſeaſed ſtomachs of animals. 14. Acid of perſpirable matter of diſeaſed animals. 15. Acid of fluors. Perhaps the number of acids is much larger; or perhaps ſome of theſe are only modifications of other primary acids; or laſtly, as Stahl ſuppoſes, they are all modifications of the one only primary acid, namely, that of vitriol. *See the theory of acids under the article* SALT.

(g) The *acid of ants* may be perceived by ſmell, on turning up an ant-hill in ſpring or ſummer. When theſe inſects are irritated, they diſcharge a fluid which has an acid taſte and ſmell. Water, or ſpirit of wine, in which they are agitated, becomes acidulous. Part of this acid is ſo volatile as to riſe by diſtillation with ſpirit of wine, in which ants had been immerſed; but the greateſt part of it is ſo fixed, as to remain united with the reſiduous phlegm. All the acid may be extracted by water, and rendered capable of riſing by diſtillation with that fluid in a water-bath. From 24 ounces of freſh ants were obtained by diſtillation, without addition, eleven ounces and two drams of acid ſpirit, ſome urinous ſalt and ſpirit, ſome empyreumatic oil, and a reſiduum, conſiſting of earth and fixed ſalt. This acid is found to have the general properties of acids. With fixed alkalies it forms neutral cryſtals, oblong, and deliqueſcent. Theſe cryſtals being diſtilled by a violent fire, yielded a liquor ſcarcely acid, and another liquor urinous or ammoniacal. From the reſiduum diſſolved in water, by filtration and evaporation, were obtained large cryſtals which did not deliquiate, and had the general properties of fixed alkalies. In this experiment the acid ſeemed to diſappear. But by pouring oil of vitriol on theſe alkaline cryſtals, white vapors were diſengaged, although no acid ſpirit could be obtained by diſtillation. From theſe white vapors, and from the facility with which this ſalt cryſtallizes, The *phoſphoric acid*, obtained from urine, appears, for the ſame reaſon, to belong to this claſs of animal acids. But it has properties ſo different from thoſe of all other acids, that it deſerves to be conſidered as a diſtinct acid. *See* PHOSPHORUS.

ACIDS (CONCRETE). Theſe are ſaline, ſolid ſubſtances which have the general properties of acids. Such are, *cryſtals of tartar*; *eſſential ſalts of vegetables*, particularly of thoſe which are acid; the *volatile acid ſalt of amber*, and of ſome other *bitumens*; and *flowers of Benjamin*.

ACIDS (FLUOR), Are thoſe which are generally, or always in a fluid ſtate; ſuch are the volatile vitriolic, nitrous, marine acids, and thoſe obtained by diſtillation from vegetable and animal ſubſtances.

ACID *of* FLUORS. *See* FLUORS.

ACID (MARINE). This is ſo called, becauſe it is generally obtained from ſea-ſalt; though it may be alſo procured from *Sal-gem*, or *foſſile ſalt*, and from the ſalt of

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Mr. Margraaf, from whom theſe and the following experiments on the acid of ants are extracted, ſuſpects the exiſtence of a latent acid. The acid of ants formed with volatile alkali an ammoniacal fluid, which, like the combination of the ſame alkali with vinegar, could not be reduced to a concrete or ſolid ſtate. With quicklime, chalk, and coral, it formed dry cryſtals.

This acid did not precipitate ſilver, lead, or mercury, from nitrous acid; hence it has no analogy to marine acid. Nor did it precipitate quicklime from marine acid; and hence it has no analogy to vitriolic acid.

As a menſtruum, this acid acted weakly upon copper, and ſtrongly upon iron and upon zinc; but it did not act, or very little, upon ſilver, lead, tin, regulus of antimony and biſmuth. Its combination with iron cryſtallized; in which reſpect it differs from vinegar. It diſſolved the calxes of copper, ſilver, zinc, and lead; but not the calxes of tin, regulus of antimony, biſmuth, or of mercury, which laſt calx it converted to fluid quickſilver. Upon the whole (ſays Margraaf), we may perceive a reſemblance in many reſpects, though not in all, betwixt this acid and the acetous. *See the Memoirs of the Berlin Academy*, vol. 4. 1749, or the *Opuſcules Chemiques de Mr. Margraaf.*

Inſects armed with ſtings, as bees, waſps, and hornets, when irritated, diſcharge an acid liquor. A very ſtrong acid has been obſerved by M. Bonnet to be ejected by a caterpillar, which he diſtinguiſhes by the name of *grande chenille du ſaule à queu fourchue.* See the *Mem. des Sçavans Etrang. Tom* 2. and *Philoſ. Tranſ. for* 1743.

ſaline fountains and pits, ſince all theſe ſalts do not differ from ſea-ſalt, but in their origin.

The marine acid, as well as the nitrous and vitriolic, is never found alone and pure; but it is always combined with an alkali, ſo as to form a neutral ſalt, which is diſſolved copiouſly in the ſea, to which it gives a ſaline taſte.

This neutral ſalt is alſo found cryſtallized in large tranſparent maſſes within the earth, and is then called *Sal-gem*, or *foſſile ſalt.*

It is alſo diſſolved in the waters of ſome *wells* or *fountains*, which may be owing to theſe waters communicating by ſubterraneous paſſages with the ſea, or to their paſſing through mines of *Sal-gem.*

The marine acid has all the general properties of ſaline acid ſubſtances.

It differs from the vitriolic acid in the following circumſtances: it is more light and volatile; it has ſmell and color; it emits vapors; it has leſs affinity with fixed alkalies and abſorbent earths; and, like the nitrous acid, it forms with abſorbent earths no ſalts but ſuch as are deliqueſcent.

It differs from the nitrous acid by its color, which is more yellow and leſs red; by the whiteneſs of its vapors, which are viſible only in open air; by its ſmell, which reſembles ſaffron; by a weaker affinity with abſorbent earths and fixed alkalies. (*h*)

The marine acid cannot be ſo much concentrated as the vitriolic and nitrous acids, becauſe it is much more volatile.

This acid cannot be ſo eaſily combined with phlogiſton as the vitriolic and nitrous, and we are not certain that ſome medium is not requiſite for ſuch a combination.

Although the properties of the marine acid are as well known as thoſe of the nitrous and vitriolic, yet chemiſts are far from underſtanding the nature of this ſaline ſubſtance equally well. Becker, according to his theory of acids, attributes the diſtinguiſhing properties of the marine acid to that principle which he calls *mercurial earth.* But he ſupports his opinion by no other proofs, than by ſome

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(*h*) Marine acid differs from the nitrous in another inſtance, beſides thoſe mentioned in the text. It readily diſſolves metallic calxes, which are little affected by nitrous acid. Hence it extracts from moſt colored earths and ſtones the metallic calxes, by which the color of theſe ſubſtances is produced.

appearances cauſed by the union of this acid with metallic ſubſtances, in which alſo he ſuppoſes this mercurial earth to be a component part. But as the exiſtence of this mercurial earth in marine acid, or in metallic ſubſtances, is not demonſtrated, nor even ſufficiently indicated; and as Becker has explained himſelf very obſcurely and confuſedly on this ſubject, what he has ſaid does not merit a deliberate diſcuſſion. Stahl, therefore, who was too judicious to be ſatisfied with appearances and probabilities, abandoned, in ſome meaſure, this part of Becker's theory, and only expreſſes a wiſh that the exiſtence of the mercurial earth could be as well aſcertained as the exiſtence of phlogiſton.

This great chemiſt, however, appears to be convinced of the primary identity of all ſaline ſubſtances; that is to ſay, he believed that they all were the vitriolic acid diſguiſed by ſome mixture. He aſſures us, even, that he has been able to tranſmute acids into each other; that is, to change the vitriolic acid into the nitrous and marine; and to reduce theſe back again into the vitriolic. But he has not publiſhed his experiments on this ſubject, perhaps becauſe he had not ſufficiently aſcertained the proceſſes, or that he choſe to reſerve to himſelf ſuch important diſcoveries. The poſſibility, therefore, of theſe tranſmutations of acids is not yet determined. (*i*)

The properties of the marine acid, above-mentioned, indicate nothing more than that it participates of the nature of both the vitriolic and nitrous acids.

Its combination with phlogiſton, which, of all its properties, might aſſiſt us moſt in our inveſtigation, has not been ſufficiently explained.

The unſucceſsful attempts made by M. Margraaf, a celebrated chemiſt of the Academy of Berlin, to combine the marine acid pure and crude, as he calls it, with phlogiſton, with a view to compoſe phoſphorus, are ſo many freſh cauſes of uncertainty, and additional motives to endeavor to illuſtrate this important object. *See* PHOSPHORUS.

Marine acid, combined to the point of ſaturation with marine alkali, called alſo mineral or foſſile alkali, forms a neutral ſalt, cryſtallizing in cubes, of an agreeable, ſaline taſte. *See* COMMON SALT, under the article SALT.

(*i*) Concerning the identity of acids, ſee the article SALT. Concerning the tranſmutation of marine acid into the acid of nitre, *ſee* alſo ACID (NITROUS).

With volatile alkali it forms a neutral, cryſtallized, and very pungent ſalt. This ſalt is ſemi-volatile, and may be ſublimed with a certain degree of heat. It is called *Sal Ammoniac.* *See* AMMONIAC.

Metallic ſubſtances are in general more difficultly diſſolved by the marine than by the vitriolic and nitrous acids, becauſe the firſt has leſs affinity than the other two with phlogiſton, which is the medium of union betwixt metals and acids.

Marine acid, when fluid, however much concentrated, and aſſiſted by any heat, cannot diſſolve gold, ſilver, platina, or mercury, in their natural or metallic ſtate. It combines, however, very well and intimately with ſilver and mercury by two methods. One of theſe is called the dry method or cementation, becauſe the acid then, in ſome meaſure, is dry, and expoſed to the greateſt heat it is capable of receiving. *See* PARTING (CONCENTRATED) and SUBLIMATE (CORROSIVE). The ſecond method is called the *humid way*, and conſiſts in ſeparating theſe metals from their ſolution in nitrous acid. *See* LUNA CORNEA, and PRECIPITATE (WHITE).

This acid, when pure and unmixed, cannot by any known method diſſolve gold or platina. But when it is mixed with the nitrous acid, it forms a menſtruum called *aqua regia*, which readily diſſolves theſe metals. *See* AQUA REGIA. From combinations of aqua regia with gold or platina, metallic ſalts are formed ſuſceptible of cryſtallization. *See* GOLD, and PLATINA. (*k*)

Pure marine acid diſſolves ſufficiently well tin, lead, copper, iron, zinc, and biſmuth; and leſs eaſily regulus of antimony: and it forms with theſe metals different ſalts, the properties of which ſee under the articles TIN, LEAD, &c. (*l*)

The general phenomena moſt remarkable in the combination of marine acid and metallic matters, are:

1. It diſſolves theſe ſubſtances with leſs heat and effer-

(*k*) By two methods gold and platina may be rendered ſoluble in marine acid: 1. by previous ſolution in aqua regia, and precipitation from that menſtruum by means of alkali; or, 2. by a previous calcination with tin or biſmuth.

(*l*) Marine acid, when boiling, diſſolves arſenic. Regulus of cobalt, and the ſemi-metal called nickel, are alſo ſoluble in marine acid: the ſolution of the former is of a reddiſh yellow color, which is changed to green by application of heat; and the ſolution of the latter is of a deep green color.

veſcence, and with fewer vapors, than nitrous acid does. This obſervation is true, even with reſpect to thoſe metals which it diſſolves moſt readily, as copper and iron.

2. It forms with all the metals which it diſſolves, excepting iron and copper, ſalts capable of cryſtallization. The cauſe of this property is, that generally it takes from metals much leſs of their phlogiſton than the nitrous acid does.

3. The metals with which it contracts the ſtrongeſt union, as ſilver, lead, mercury, and the regulus of antimony, are actually thoſe with which it unites moſt difficultly. We muſt here obſerve, that marine acid ſeparates ſilver, lead, and mercury, from the nitrous acid in which they had been previouſly diſſolved; and when it is once united with theſe metals, they adhere more ſtrongly to it than they did to the nitrous acid. This has given occaſion to Becker and other chemiſts to advance, that in marine acid, and in the laſt mentioned metals, there is more of that principle which they call *mercurial earth*, than in any other acids or metals. And to this abundance of mercurial earth they attribute the ſtronger connection of marine acid, and the mentioned metals, which are diſtinguiſhed from all others by the appellations *white*, *lunar*, and *mercurial*.

4. Marine acid has the property of volatiliſing, or carrying off with it in ſublimation or diſtillation, entirely or partly, the metals with which it is united, thoſe particularly with which it forms the ſtrongeſt union, as mercury, regulus of antimony, ſilver and lead. *See* SUBLIMATE (CORROSIVE), LUNA CORNEA, BUTTER of ANTIMONY, and PLUMBUM CORNEUM.

5. Marine acid, though in ſome reſpects leſs ſtrong than the vitriolic or nitrous, forms with metallic ſubſtances, and particularly with the laſt mentioned metals, with which it adheres moſt firmly, *metallic ſalts*, much more corroſive than thoſe formed by the other two acids. *See* CAUSTICITY.

The greateſt part of theſe phenomena, peculiar to marine acid, evidently proceeds from the difficulty with which it unites with phlogiſton, and from the ſmallneſs of the quantity of that principle which it takes from metallic ſubſtances.

However, theſe phenomena, thus collected, may, by being compared together, furniſh matter for curious ſpeculations concerning the famous mercurial earth of Becker, which, according to him, is the third principle of metallic ſubſtances. Beſides, in moſt ſolutions of metals by marine acid, a ſingular ſmell, reſembling the ſmell of garlic, or of arſenic, is exhaled: but, according to Becker, arſenic contains abundantly the mercurial principle.

The difficulty with which marine acid combines with the inflammable principle, is the reaſon why this acid acts ſo little upon oils and oily ſubſtances. It ſeems to have no power over theſe ſubſtances when it is fluid and united with a certain quantity of water. What it would produce, if it were artfully applied to theſe oleaginous matters in its higheſt degree of concentration, with the help of conſiderable heat, is not known. Very intereſting reſearches remain yet to be made upon this ſubject.

It appears that the inflammable principle, when intimately united with water, as in ardent ſpirits, is in the favorable ſtate for combination with marine acid; although many more difficulties are found in making this combination with the marine acid, than with the vitriolic or nitrous.

Marine acid, mixed with the ſpirit of wine in all proportions, and frequently diſtilled with it, is much leſs intimately combined than the other two acids, and proportionably loſes leſs of its acidity than they do. *See* SPIRIT of SALT (DULCIFIED).

Lately, however, marine acid has been applied to ſpirit of wine in ſuch a manner, that from their union reſults a liquor which has the diſtinguiſhing properties of ether, and is a true *marine ether*. *M. Beaumé*, an able artiſt, and excellent obſerver, was the firſt who publiſhed that he had ſucceeded in making this combination. His method was by applying the vapors of highly concentrated marine acid to the vapors of ſpirit of wine, by means of a convenient apparatus of veſſels. The detail of this fine experiment may be ſeen in his *Diſſertation on Ether*. *See* ETHER (MARINE).

Afterwards, an illuſtrious and learned lover of chemiſtry* has found a method of making marine ether much more eaſily, and more abundantly, by diſtilling along with ſpirit of wine the *ſmoaking ſpirit of Libavius*, which is nothing more than highly concentrated marine acid, charged with a conſiderable quantity of tin, which it had carried up with it in diſtillation. *See* SPIRIT (SMOAKING) of LIBAVIUS.

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* The Marquis de Courtanvaux.

M. Pott, in his diſſertation de *acido ſalis vinoſo*, and other chemiſts, mention the mixture of ſome metallic ſalts, containing concentrated marine acid, ſuch as butter of antimony with ſpirit of wine. The phenomena which accompanied theſe mixtures, ſhewed that theſe ſubſtances re-acted conſiderably on each other, and conſequently might be intimately combined.

Theſe phenomena, and particularly the eaſy production of marine ether, by the ſmoaking ſpirit of Libavius, prove that the marine acid which has been combined with metallic ſubſtances, is in the fitteſt ſtate for its intimate combination with ſpirit of wine, and for the formation of an ether. Does it acquire this property, by depoſiting along with the metals a portion of ſome of its principles; for inſtance, of its mercurial earth; or by carrying off ſome of the principles of the metals? To me the latter ſeems certainly the method; and that the metallic principle which it carries off is the phlogiſton of the metals. The beſt means of deciding this intereſting queſtion, is to combine the acid with ſeveral metallic ſubſtances, particularly with thoſe which contain much phlogiſton and eaſily part with it, as zinc, regulus of antimony, tin, and iron, and then to ſeparate the acid from theſe ſubſtances; not only to try whether ether can be made by the acid thus prepared, but alſo to aſcertain by the other means which chemiſtry affords, whether the acid be really by this method combined with a portion of the phlogiſton of the metals. Mr. Pott, as well as Stahl, affirms a fact which confirms theſe notions, and which well deſerves to be aſcertained; which is, that the properties of the nitrous acid may be given to the marine by combining the latter with iron. (*m*) But it is very certain, that the principal difference betwixt theſe two acids proceeds from the quantity of phlogiſton which enters as a principle into the compoſition of the nitrous. *See* ETHER (MARINE).

The affinities of marine acid, according to Mr. Geoffroy's Table, are in the following order: tin, regulus of antimony, copper, ſilver, mercury. According to Mr. Gellert,

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(*m*) This fact has not been aſcertained by ſome later chemiſts, the Duke D'Ayen, and M. Machy, who, led by the authority of Stahl, have in vain attempted to tranſmute the marine acid into the nitrous. Nevertheleſs, Dr. Prieſtley relates that Mr. Woulfe, a very able chemiſt, has effected the change of the marine into the nitrous acid, and alſo of the nitrous into the marine. *Experiments and Obſervations on Air*, *Vol.* II. *p.* 161.

Gellert, its affinities are placed thus: phlogiſton, zinc, iron, copper, tin, lead, biſmuth, regulus of antimony, mercury, arſenic. This Table ſhews alſo that it does not diſſolve gold, and partly diſſolves ſilver by the dry method. (*n*)

ACIDS (MINERAL). Mineral acids are thoſe which are obtained from minerals, or ſubſtances dug from the earth; ſuch as *ſulphur*, *bitumens*, *alum*, *ſelenites*, *vitriols*, *clays*, all which contain *vitriolic acid*; the *nitrous earths*,

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(*n*) The affinity of tin is greater than that of copper to marine acid, according to Mr. Geoffroy's Table, and leſs, according to Mr. Gellert's Table. I have obſerved that tin readily precipitates copper from this acid, and alſo from aqua regia: Mr. Gellert is therefore miſtaken. The affinities of this, and alſo of other acids to metals, vary in different circumſtances. Thus, for inſtance, although marine acid unites generally with copper or with iron, preferable to mercury, or regulus of antimony; yet if either of theſe latter metallic ſubſtances be added to a mixture of ſea-ſalt and vitriol, green or blue, and conſiderable heat applied, the marine acid of the ſea-ſalt, diſengaged from its baſis by the acid of the vitriol, will not unite with the iron or copper of the vitriol, but with the mercury or regulus of antimony, and along with them will be raiſed by the force of the fire, forming mercury ſublimate, or butter of antimony.

Mr. Hellot found, that by repeatedly drying and diſtilling the mother water of ſea-ſalt, more and more marine acid could be obtained without addition.

Marine acid renders calcareous earths and metals ſoluble in ſpirit of wine; but it does not render volatile alkali ſoluble in ſpirit of wine, as nitrous acid does; nor fixed alkali, as acetous acid does.

Marine acid, together with burning phlogiſton, gives a reddiſh yellow flame. The marine acid of mercury corroſive ſublimate, combined with copper, forms a fuſible maſs, which kindles like ſulphur, and burns with a blue flame. The phoſphorus of Homberg, which is a combination of the marine acid of ſal ammoniac with calcareous earth, to which a portion of the inflammable principle of the ſal ammoniac adheres, is luminous when ſtruck in the dark. From theſe facts, together with the preparation of marine ether, we may perceive that marine acid is capable of uniting with phlogiſton, and that a marine ſulphur might probably be formed, if the volatility of marine acid did not prevent the application of heat ſufficient for the forming of that combination.

Homberg found, that marine acid corrodes glaſs more than the vitriolic or nitrous acids. For the proceſs of obtaining marine acid, *ſee* Spirit *of* Salt.

from which nitrous acid is obtained; and *Sal-gem*, ſea-ſalt, or *common ſalt*, which furniſh marine acid.

There are then three mineral acids, the vitriolic, nitrous, and marine. Theſe acids are generally more ſimple, leſs volatile, more ſuſceptible of concentration, and ſtronger than the acids obtained from animals or vegetables. Hence their power of decompoſing all the neutral ſalts whoſe acids are of the latter kind, of diſengaging theſe acids, and of ſubſtituting themſelves in their place by uniting with the ſubſtance, which together with the animal or vegetable acid had formed the neutral ſalt. *See* ACID, ACID (VITRIOLIC), ACID (NITROUS), ACID (MARINE).

ACID (NITROUS). Nitrous acid has all the general properties of ſaline acid ſubſtances, mentioned under the article Vitriolic Acid. *See* ACID (VITRIOLIC). But it differs from vitriolic acid in the following circumſtances:

1. It is lighter than the vitriolic. The weight of the moſt concentrated nitrous acid, which can be obtained by ordinary means, is to the weight of water as 19 to 12. See a memoir of Mr. Rouelle concerning the inflammation of oils, in the Memoirs of the Academy for the year 1747.

2. It is of a yellowiſh-red flame color.

3. It is leſs fixed than vitriolic acid, and cannot therefore be ever obtained in a concrete form, when unmixed.

4. It perpetually exhales in vapours of the ſame color as itſelf.

5. Its ſmell and taſte are peculiar and diſtinguiſhing.

6. When highly concentrated, it ſtrongly attracts the moiſture of the air, but leſs ſtrongly than vitriolic acid highly concentrated.

7. When concentrated nitrous acid is mixed with water, a conſiderable heat and ebullition are produced from the activity with which theſe two ſubſtances combine. While they are mixing, a ſingular and curious phenomenon appears, which is, that the liquor aſſumes a blue or deep green color, while the vapors continue ſtill of their original yellowiſh red. M. Beaumé has made this obſervation.

This blue color, as the ſame chemiſt has remarked, diſappears in a few days, if the nitrous acid has been diluted with much water.

Concentrated nitrous acid is very corroſive. It tinges the ſkin with a yellow color, which does not diſappear till the epidermis comes off. It is ſucceſsfully employed to corrode and gradually deſtroy warts, and uninflamed, indolent tumors.

If the opinion of Becker, Stahl, Junker, and all the ſcholars of Stahl be true, that there is only one primitive acid, whence the reſt are formed; and that this moſt ſimple acid, the principle of all others, is the vitriolic, then it follows that nitrous acid is nothing elſe than vitriolic acid, changed by the union of ſome other principle. Further, theſe chemiſts think that nitrous acid is formed from the vitriolic, combined, by means of the putrid fermentation, with a certain quantity of phlogiſton. To prove their opinion, they give the following reaſons:

1. That the nitrous acid is obtained from nothing elſe than materials impregnated with putrid juices of animal and vegetable ſubſtances, which are known to abound with phlogiſton: whereas vitriolic acid exiſts in moſt minerals, and in the very earths and ſtones, which are fitteſt to form a matrix for the generation of nitrous acid.

2. There is a great analogy betwixt thoſe properties of the nitrous and volatile vitriolic acids, by which each of theſe acids differs from vitriolic acid; and volatile vitriolic acid is evidently vitriolic acid changed by union with phlogiſton.

This volatile vitriolic acid differs from vitriolic acid by its volatility, by its ſmell, by its weaker adheſion to alkaline ſalts, by the greater ſolubility and different form of the cryſtals reſulting from its union with alkaline ſalts.

But theſe properties are the ſame which diſtinguiſh nitrous acid from the vitriolic. Beſides, the volatile vitriolic and nitrous acids reſemble each other, and differ from vitriolic acid in the following reſpects: 1. They produce a much greater alteration on the colors of vegetables than the vitriolic does: and, 2. The ſalts formed by their combination with fixed alkali reſemble each other, and are equally different from vitriolated tartar.

Several new intereſting experiments might be made to determine more particularly the analogy betwixt the volatile vitriolic and nitrous acids. The ſalt reſulting from the combination of volatile vitriolic acid and abſorbent earths might be examined, in order to diſcover whether it be deliqueſcent, like the ſalt from the combination of the ſame earth with nitrous acid, and in what other circumſtances theſe two ſalts reſemble each other, and differ from the vitriolic ſalt with earthy baſe, or ſelenites. This inquiry would be ſtill more intereſting, as the nitrous ſalts with earthy baſes have alſo been little examined. *See* SALTS (NITROUS) *with* EARTHY BASES.

Nitrous acid is one of the moſt powerful menſtruums in chemiſtry: not that it is the ſtrongeſt acid; for in ſtrength it is inferior to vitriolic acid, and even in certain circumſtances to marine acid: but on account of the facility, of the quickneſs, and of the activity with which it diſſolves moſt ſubſtances.

The bodies upon which it acts moſt forcibly are, phlogiſton, alkalis fixed and volatile, metallic ſubſtances and earths, particularly of the calcareous and abſorbent kinds.

Nothing can equal the impetuoſity with which nitrous acid joins itſelf to phlogiſton. It is ſo great, that probably nitrous acid has a ſtronger affinity with phlogiſton than the vitriolic has: and it is probable too, that this proceeds from the phlogiſton being one of the principles of nitrous acid.

The phenomena exhibited by nitrous acid with all matters containing phlogiſton, are different according to the ſtate of theſe matters, and of the acid itſelf.

When the phlogiſton of the ſubſtances applied to nitrous acid is in ſmall quantity, and inveloped in much uninflammable matter, and when the nitrous acid is diluted in much water, from which it cannot diſengage itſelf in the act of combination, then it diſſolves theſe ſubſtances always with more facility, quickneſs, and activity than the other acids, all circumſtances being ſuppoſed alike; but it diſſolves them without being itſelf decompoſed, and forms along with them new combinations. But when the ſubſtances to which the nitrous acid is applied, contain much phlogiſton, as ſulphur, oils, charcoal, and many metallic matters; and when the nitrous acid is dephlegmated as much as is poſſible; or when it can, in the very act of combination, become dry, and receive at the ſame inſtant the heat of ignition, whether this heat be applied to it, or it be generated by the violence of the re-action; then does the nitrous acid, in this ſtate of heat and dryneſs, combine intimately with the phlogiſton, and form with it a kind of ſulphur or nitrous phoſphorus, which is inſtantaneouſly inflamed and decompoſed in ſuch a manner, that not only the phlogiſton, but alſo the nitrous acid itſelf, is entirely burnt and deſtroyed. And this combuſtion is effected differently from all others, without the neceſſity of acceſs of air. Hence the inflammations, the detonations, the exploſions, which always happen when all theſe circumſtances concur. *See* DETONATION *of* NITRE *with ſulphur, &c.* GUNPOWDER, FULMINATING POWDER, FULMINATING GOLD, INFLAMMATION *of* OILS.

Nitrous acid forms with fixed vegetable alkali a neutral cryſtallizable ſalt, called *nitre*, or *ſalt-petre.* *See* NITRE.

With marine or foſſile alkali it forms a cryſtallizable ſalt, called *cubic*, or *quadrangular nitre*, from the figure of the cryſtals. *See* NITRE (CUBIC).

With volatile alkali it forms a neutral ſalt, capable of cryſtallizing, called *ammoniacal nitre*, or *nitrous ſal ammoniac.* This ſalt has the property of detonating without addition of phlogiſton, becauſe phlogiſton is contained in the volatile alkali. *See* AMMONIAC (NITROUS).

Nitrous acid diſſolves with much facility and readineſs all calcareous and abſorbent earths, and forms with them neutral ſalts not capable of cryſtallization; undoubtedly becauſe of the ſmall adheſion of this acid with the earths. Theſe ſalts, when dryed and expoſed to the air, deliquiate or melt into a liquor. They are called *nitre with earthy baſe*, or *nitrous ſelenites.*

The action of nitre upon other earths is not yet well known. *See* NITRE *with* EARTHY BASIS.

Nitrous acid attacks and diſſolves in general all metallic ſubſtances, gold and platina excepted, which it alſo diſſolves when it is united with marine acid; and the marine acid is likewiſe incapable of diſſolving theſe metals without the aſſiſtance of nitrous acid.

The phenomena preſented by nitrous acid in metallic ſolutions are very numerous. The particulars may be ſeen under the articles of each metal. We ſhall only here make ſome general obſervations upon this ſubject.

1. Nitrous acid, in diſſolving metallic ſubſtances, emits a great quantity of red vapors; and *cæteris paribus*, produces more heat than when it diſſolves alkaline ſalts or earths; which can only be attributed to the phlogiſton of metallic ſubſtances.

2. There are metallic ſubſtances with which nitrous acid forms ſalts capable of cryſtallization and detonation. Such are particularly ſilver, lead, mercury, and biſmuth. With moſt other metals, as with copper, tin, iron, and regulus of antimony, it forms deliqueſcent metallic ſalts, which partly are decompoſed ſpontaneouſly by the ſeparation of the metallic part. This difference proceeds from the greater or leſs quantity of phlogiſton, which the nitrous acid takes from the metals in ſolution. Thoſe metals from which it takes little phlogiſton, form with it more intimate combinations, becauſe they retain a good deal of that principle which is the medium of union betwixt their earth and the

acid. On the contrary, the ſolution of the metals from which this acid takes much phlogiſton, is attended with much more ebullition and violence: and when the acid is ſtrong, when the quantities of the acid and metal are large, and the metal reduced to filings or grains, then the heat, the ebullition, and the exhalation of vapors are carried to their higheſt point, almoſt to inflammation. It is even probable that a real inflammation might be produced, if the experiment were puſhed far enough.

A remarkable phenomenon, which has not been attended to, is, that the metals from which nitrous acid takes leaſt phlogiſton, are thoſe which form with it the moſt corroſive ſalts; ſo that mercurial nitre and the nitre of lead are true poiſons. This remark may help to explain the corroſive quality, or cauſticity, which the combinations of the mineral acids with metallic ſubſtances generally have. *See* CAUSTICITY.

Nitrous acid is eaſily combined with all oils, and with all oily and inflammable matters. It acts upon theſe matters more ſlowly and weakly, in proportion as it is more diluted with water. It thickens them, and forms with them reſinous or ſaponaceous compounds, according to their nature and the proportion of the acid. When the acid is very concentrated, it burns and inflames them. *See* INFLAMMATION *of* OILS.

It eaſily unites, even when much diluted with water, with ſpirit of wine. It combines intimately with that ſubſtance, and thereby loſes much of its acidity. It is then called *ſpirit of nitre dulcified*; which *ſee*.

With proper proportions and management, it changes part of the ſpirit of wine into a liquor which has the principal properties of vitriolic ether. *See* ETHER (NITROUS).

The affinities of nitrous acid are, according to Mr. Geoffroy's Table, iron, copper, lead, mercury, ſilver: and according to Mr. Gellert, phlogiſton, zinc, iron, regulus of cobalt, copper, biſmuth, lead, mercury, regulus of antimony, ſilver, arſenic, and tin. The tin is there ſaid to be only partly ſoluble, undoubtedly becauſe of the abundant precipitation of the earth of the tin, which the nitrous acid deprives of its phlogiſton, and in ſome ſort calcines rather than diſſolves. *See* TIN. (*o*)

(*o*) Nitrous acid forms with copper, a green; with iron, a reddiſh; with lead, a yellow; and with ſilver, biſmuth, mercury, and

ACID (PHOSPHORIC). *See* PHOSPHORUS.

ACID (VOLATILE SULPHUREOUS), or (VOLATILE VITRIOLIC). This is nothing elſe than vitriolic acid diluted with water, and weakly united to the inflammable principle. The properties of this acid are then the ſame *eſſentially* as thoſe of vitriolic acid. *See* ACID (VITRIOLIC). But the phlogiſton which is united with the volatile acid makes it differ conſiderably from the pure vitriolic acid.

It differs from vitriolic acid, 1. By its ſmell, which is ſo active and penetrating, that it can inſtantaneouſly ſuffocate and kill animals. This ſmell is the ſame as that of lighted ſulphur. As vitriolic acid, when pure and free from phlogiſton, has no ſmell, it appears that the ſmell of volatile vitriolic acid is cauſed by its phlogiſton; and this is one of the beſt proofs of the opinion of Stahl and other chemiſts, who think that phlogiſton is the principle of all odors. This opinion will appear even demonſtrated, when we conſider that no odoriferous ſubſtance can be found, in which it is not eaſy to ſhew the preſence of phlogiſton. *See* PHLOGISTON.

2. The volatile acid differs from the vitriolic by its volatility. The latter is the moſt fixed of the mineral acids, and is for that reaſon the moſt ſuſceptible of concentration: but the volatility of the former is ſo great, that it cannot be much concentrated. This property proves that phlogiſton is a principle eſſentially volatile.

3. The volatile acid is infinitely weaker than vitriolic acid; not only becauſe it cannot be ſo much concentrated, but alſo by its combination with phlogiſton it is rendered leſs ſimple, and conſequently leſs capable of affinity with

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and zinc, colorleſs ſolutions. Tin it diſſolves imperfectly, and it corrodes regulus of antimony to a white powder. With regulus of cobalt it forms a red, and with nickel a green ſolution. It diſſolves arſenic, and, according to Henckel and Neuman, forms with it a gum-like ſubſtance. Dr. Brandt found that by particular management it can diſſolve gold. *See* GOLD. It has little effect on metallic calxes.

Nitrous acid combined with chalk forms the phoſphorus of Baldwin. *See* PHOSPHORIC STONES. Cohobated and diſtilled with quicklime, it emitted an inflammable vapor. *See Mr. Pott's Diſſertation on the Solution of Quicklime by Nitrous Acid.* With ice this acid produces cold remarkably. Concerning the origin of nitrous acid, *ſee* NITRE *and* SALT; and for the proceſs of obtaining it, *ſee* SPIRIT *of* NITRE.

other bodies. Therefore, the neutral ſalts formed by it with alkalis, are eaſily decompoſed by vitriolic acid, and alſo by all other acids, even the weakeſt amongſt the vegetable.

4. The neutral ſalt which reſults from the union of volatile vitriolic acid and fixed alkali, differs much from vitriolated tartar with reſpect to the figure of its cryſtals, which are long and needle-like, arranging themſelves together in form of tufts or ſhrubs. Its taſte alſo is different from that of vitriolated tartar, and it is more ſoluble in water: all theſe properties ſhew in a neutral ſalt the weak union of its acid and baſe. This ſalt is called the *ſulphureous ſalt of* STAHL. *See* SALT (SULPHUREOUS).

5. The action of the volatile vitriolic acid is much more evident than of vitriolic acid upon the colors of vegetables, as appears by pouring an equal quantity of each of the two acids into the tincture of violets, or of heliotrope, of cochenille, Braſil wood, &c. In all theſe inſtances, the tinctures into which volatile vitriolic acid has been poured, will have loſt much more of the intenſity of their colors than the other tinctures; that is to ſay, their colors will be more changed, enlivened, and heightened. This effect is produced to ſuch a degree by this acid, that it deſtroys moſt colors, and makes them diſappear entirely in time. This property renders it very uſeful in ſeveral arts, by giving to certain matters, for inſtance to wools and ſilks, a degree of whiteneſs to which they could not be otherwiſe brought. For this purpoſe, theſe matters are expoſed in a cloſe place to the fumes of burning ſulphur, from which, as we ſhall afterwards ſee, much of this acid exhales. *See* SULPHUR.

Although volatile vitriolic acid differs eſſentially from nitrous acid, ſince the former is nothing elſe than vitriolic acid diſguiſed by the addition of phlogiſton, which is but weakly united to it; nevertheleſs, it is neceſſary to remark, that all the properties now recited of the volatile acid, make it reſemble nitrous acid as much as they diſtinguiſh it from vitriolic acid. From this remark may be drawn one of the ſtrongeſt preſumptions in favor of Stahl's opinion concerning the nature of nitrous acid. This great chemiſt thinks, that vitriolic acid, which he therefore calls the *univerſal acid*, is the principle of all other acids, and the moſt ſimple of all. He thinks that nitrous acid particularly is nothing elſe than vitriolic acid combined by means of putrefaction with a certain quantity of phlogiſton; but in a manner very different, and infinitely more intimately than the phlogiſton is combined in volatile vitriolic acid. For this latter combination is ſo weak, that it is decompoſed by contact of air; ſo that the moſt ſtrong and penetrating volatile vitriolic acid, by expoſure in open veſſels, loſes in a little time all its ſmell and volatility, and becomes entirely ſimilar to a pure and weak vitriolic acid. The ſame phenomenon takes place when the volatile acid is combined with an alkali. Hence the ſulphureous ſalt of Stahl, expoſed for a while to free air, loſes all the properties which diſtinguiſh it from vitriolated tartar, and becomes no-wiſe different from it.

The true reaſon of the weakneſs of adheſion of the phlogiſton in volatile vitriolic acid, is the preſence of the aqueous principle, above the quantity of water eſſential to vitriolic acid. This principle always reſiſts a ſtrong and intimate union of phlogiſton with any body.

This is ſo true, that if vitriolic acid deprived of all water except what is eſſential to it, be applied to any matter containing phlogiſton, volatile vitriolic acid is not then produced, but true ſulphur, in which the phlogiſton adheres more ſtrongly. *See* SULPHUR. On the contrary, when a vitriolic acid, overcharged with ſuperfluous water, is combined with a matter containing phlogiſton, volatile vitriolic acid is conſtantly produced, and never ſulphur, except that in the very act of combination the vitriolic acid be deprived of all its ſuper-abundant water.

The great facility which vitriolic acid has to combine with phlogiſton, even when ſuperfluous water is mixed with it, furniſhes many methods of producing abundantly this volatile vitriolic acid.

Stahl propoſes two. The firſt is, by burning ſulphur as ſlowly and gently as poſſible. The acid which exhales in this operation is very volatile, very phlogiſticated, and very ſuffocating; for two reaſons: 1. Becauſe of the little activity with which the ſulphur burns, the inflammable principle is not entirely conſumed, but a portion of it remains united to the acid: and, 2. Becauſe when the vitriolic acid, which in ſulphur is in its higheſt degree of concentration, and even in a ſtate of perfect dryneſs, diſengages itſelf by degrees, during the ſlow burning of the ſulphur; it finds in the air a portion of water which it greedily ſeizes, and which renders it fit to be changed with the remaining phlogiſton into volatile vitriolic acid. When ſulphur is burnt haſtily and ſtrongly, little or no volatile vitriolic acid is produced, principally becauſe then almoſt all the inflammable principle of the ſulphur is deſtroyed by this perfect inflammation.

This firſt method of obtaining the volatile vitriolic acid is the beſt and eaſieſt, when it is not intended to collect it, but to apply it to ſome body as ſoon as it is produced; as, for example, to kill inſects or noxious animals, to whiten wools and ſilks, to ſulphurate wines, or to produce the ſulphureous ſalt of Stahl. *See* SALT (SULPHUREOUS). *See* alſo SULPHUR. But this method is improper for collecting the volatile acid, becauſe ſulphur cannot burn in cloſe veſſels.

The ſecond method propoſed by Stahl for obtaining the volatile vitriolic acid, is by diſtilling green or martial vitriol in a cracked retort, to which a receiver is properly luted. By this method a conſiderable quantity is produced and collected; becauſe, 1. The phlegm of the martial vitriol ſupplies the neceſſary water to the vitriolic acid; and, 2. Enough of the phlogiſton of the burning coals paſſes through the crack of the veſſel, to form volatile vitriolic acid. This method, though very good in itſelf, is ſubject to a very great inconveniency in practice; which is, that when cracked retorts are expoſed to the fire with the greateſt caution, they are very apt to break ſtill more, and entirely to fall in pieces, by which the operation is ſpoiled.

This inconveniency may be avoided by diſtilling in a good retort, not cracked, a mixture of vitriolic acid, or ſubſtance containing it, and any matter capable of furniſhing at once water and phlogiſton. Thus ſpirit of wine, oils, fat, reſins, &c. mixed and diſtilled with vitriolic acid, can always furniſh a good quantity of ſtrong volatile vitriolic acid. *See* OIL *and* ETHER (VITRIOLIC).

This acid ought to be kept in glaſs bottles, cloſed exactly with glaſs ſtoppers; and to be as little as poſſible expoſed to air, becauſe vapors always exhale from it when ſo expoſed, by which its ſtrength is impaired from the diſſipation of part of its phlogiſton.

This great facility which the phlogiſton has to ſeparate itſelf from volatile vitriolic acid, is the cauſe of the exceeding difficulty, and even impoſſibility of determining preciſely the quantity of phlogiſton neceſſary to convert any given quantity of vitriolic acid into volatile vitriolic acid. In general, we know that very little is required; a ſingle drop of oil being capable of converting, by diſtillation, a large quantity of vitriolic acid into very ſtrong volatile acid.

It is no leſs difficult to determine certainly and preciſely the properties of this acid as a menſtruum of different ſubſtances; as, for example, earths and metals. This difficulty alſo proceeds from the facility with which it parts with its phlogiſton, and conſequently changes its nature, which it does more or leſs in the act of combination with the ſubſtances which it diſſolves. It is an acid perpetually changing, and which we cannot be certain of having the ſame at different times.

Theſe difficulties ought not to prevent trials of ſuch combinations, hitherto little known. Becauſe in an important and eſſential enquiry, which may throw new light upon the theory of acids and phlogiſton, even approximations become important and eſſential.

ACID (TARTAREOUS). *See* TARTAR, and CREAM *of* TARTAR.

ACIDS (VEGETABLE). All acids obtained from vegetable matters are ſo called. Such are the juices of ſour fruits, wine turned ſour, or vinegar; cryſtals of tartar; all the eſſential, acid, concrete ſalts, procured by cryſtallization from the expreſſed juices of plants; and laſtly, all the acids obtained from vegetable ſubſtances in analyſing them by diſtillation.

Theſe acids differ from mineral acids in being leſs ſimple, leſs fixed, leſs ſuſceptible of concentration, and weaker; qualities, which proceed from their union with a certain quantity of oil, with which they are ſo intimately combined, that they cannot be ſeparated from it but by very nice and ſtudied operations. Hence all the neutral ſalts formed by theſe acids may be decompoſed, either by the mere action of the fire, or by any mineral acid whatever.

The particulars of what is here advanced in general on their properties and principles, may be ſeen under the articles of the principal vegetable acids.

ACID (VITRIOLIC) was ſo named, becauſe, formerly, it was chiefly obtained from martial vitriol. It is, according to the very probable opinion of Becker and of Stahl, the ſimpleſt of all acids, and conſequently the ſimpleſt of all ſaline ſubſtances. When it is as pure as can be obtained, it is entirely free from ſmell and color; that is to ſay, in theſe reſpects, it reſembles water.

It poſſeſſes moſt eminentlyall the properties characteriſing ſaline, and particularly acid ſubſtances.

It taſtes exceedingly ſour, and it ſets the teeth on edge.

It changes to red the color of ſyrup of violets, of tincture of heliotropium, &c.

It is very ſuſceptible of concentration; that is, much of the water unneceſſary to its ſaline eſſence may be raiſed by diſtillation. *See* CONCENTRATION.

The ſpecific gravity of this acid, when much concentrated, is very great. It is more than double the ſpecific gravity of water, ſometimes as 17 to 8, and perhaps might be further concentrated. M. Hellot, in puſhing ſtrongly the diſtillation of martial vitriol, obtained towards the end of the operation a vitriolic acid ſo concentrated, that it was ſolid and cryſtalline. Some chemiſts have given to vitriolic acid ſo concentrated as to become concrete, the name of GLACIAL, or ICY OIL *of* VITRIOL.

Vitriolic acid highly concentrated is leſs fluid than water. It pours ropey like oil, and feels to the fingers greaſy. Theſe two laſt properties have occaſioned the ancient chemiſts to call it *Oil of Vitriol.* This name is very improper, ſince it is not inflammable, nor has any peculiar properties of oils. *See* OILS. Its oily conſiſtence is owing to the great approximation of its parts, and its apparent unctuoſity proceeds from the ſame cauſe; joined to this, that as it is a very powerful diſſolvent, it attacks and diſſolves effectually a portion of the unctuous ſubſtance of the ſkin which it touches.

The very ſtrong and concentrated vitriolic acid is not only much heavier, but alſo much more fixed than water. Hence it is capable of receiving, when expoſed to fire, a degree of heat greatly ſuperior to that of boiling water, and which almoſt amounts to a red heat.

This acid, when well concentrated, (which we ſuppoſe here all along) unites with water with an aſtoniſhing activity and impetuoſity. If two or three ounces of it be mixed with as much pure and cold water, the re-action of theſe two ſubſtances on each other is ſo ſtrong, that inſtantly a boiling ariſes, attended with many vapors, and a noiſe ſimilar to that of red-hot iron plunged into water. The heat reſulting from the re-action of theſe two cold liquors is ſo great, that in an inſtant it equals, and even much ſurpaſſes the heat of boiling water. Some chemiſts have attributed this heat to a diſengagement of the igneous particles contained in vitriolic acid. This is not true, except they only mean the igneous particles contained in this acid, as in all other ſubſtances, and which are ſet in motion by all colliſions;

but not any ſuperabundant igneous particles peculiar to this acid, ſince no experiment demonſtrates their exiſtence.

The concentrated vitrolic acid, expoſed to the atmoſphere, attracts moiſture ſo much, that its bulk is conſiderably encreaſed, and it becomes mixed with twice its weight of water. *(p)*.

It may be combined with the inflammable principle or phlogiſton, and thereby form two compounds, differing from each other in the quantity of phlogiſton, and in the cloſeneſs of the union.

The firſt, which is the reſult of a combination of weak vitriolic acid with a ſmall quantity of phlogiſton, is called volatile ſulphureous acid, or volatile vitriolic acid. *See* ACID (SULPHUREOUS); and the ſecond, which ariſes from an intimate union of vitriolic acid, freed from all water above what is neceſſary to its eſſence as a ſaline ſubſtance, with about a ſeventh part of its weight of pure phlogiſton, is called *Sulphur*. *See* SULPHUR.

Earths are more or leſs ſoluble by vitriolic acid, according to their natures; and form with it different ſalts, or earthy ſaline compounds of different properties, according to the kinds of earth employed. Particular management is requiſite to combine vitrifiable earths with vitriolic acid: and the ſalts reſulting from their combination have not yet been ſufficiently examined. *See* VITRIFIABLE EARTHS *and* LIQUOR *of* FLINTS.

Calcareous earths may be diſſolved without any previous preparation by vitriolic acid. This ſolution is made with moderate effervescence; and from this combination reſults an earthy ſaline compound, ſuſceptible of cryſtallization, whoſe principles are ſo intimately combined, that the ſaline properties of the vitriolic acid are almoſt entirely hid and covered by thoſe of the earth which is the prevailing principle (*ſee* AFFINITY); ſo that this neutral vitriolic ſalt with

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(p) Dr. Gould relates, that three drams of concentrated vitriolic acid acquired by imbibing moiſture from the air, in 57 days, an increaſe of ſix drams and a half; and that in general this acid acquires increaſe of weight in a compound ratio of the largeneſs of the ſurface expoſed, and of the humidity of the atmoſphere. Neuman found that an ounce of this acid, by expoſure to air during a year, had imbibed more moiſture than ſix times its original weight. For the method of obtaining this acid, *ſee* SPIRIT *of* SULPHUR, CLYSSUS *of* SULPHUR, *and* CONCENTRATION *of* VITRIOLIC ACID.

earthy baſis has no ſenſible taſte, and is ſcarcely ſoluble in water: according to Mr. Baumé's experiment, one grain only of it could be diſſolved in an ounce of water. This want of ſaline properties, which appears common to all vitriolic ſalts with baſes of calcareous earth, has occaſioned them to be diſtinguiſhed by the name of *Selenites*, from other combinations whoſe ſaline properties are more obvious. *See* SELENITES.

Alum is a vitriolic ſalt with earthy baſis, but it differs conſiderably from Selenites. This difference proceeds from the nature of its earthy baſis, which is not calcareous, but argillaceous. *See* ALUM.

Vitriolic acid may be combined and ſaturated with vegetable fixed alkali: and from this combination is formed a neutral ſalt, capable of being cryſtallized, bitter, hard, and not eaſily ſoluble in water. Several names were given to this ſalt from the ſeveral ſubſtances whence its alkaline baſis was extracted, at a time when theſe alkalies were ſuppoſed to differ from each other. Theſe names are, *Sal de duobus*; *vitriolated tartar*; *arcanum duplicatum*. *See theſe words, and* ALKALI (VEGETABLE).

With the alkaline baſis of ſea ſalt, called marine or foſſile alkali, the vitriolic acid forms a neutral, cryſtallizable ſalt, called *Glauber's ſalt*, which differs from vitriolated tartar in the figure of its cryſtals, its greater ſolubility in water, the quantity of water contained in its cryſtals, and its property of drying in the air, or loſing much of its water, by which the cryſtals loſe their tranſparency, their ſolidity, and are reduced into a white meal, called *efflorеſcence*. *See* ALKALI (MARINE), *and* SALT *of* GLAUBER.

Volatile alkali combined to the point of ſaturation with a vitriolic acid, forms a neutral ammoniacal ſalt, and cryſtallizable, called *Salt (Vitriolic Ammoniac), which ſee, and* ALKALI (VOLATILE).

Vitriolic acid being more ſimple and more powerful than the nitrous and marine acids, ſeparates them from the alkalis to which they are united, and ſubſtitutes itſelf in their place. *See* NITRE *and* SALT (COMMON).

In general, this acid acts upon all metallic ſubſtances, and diſſolves them with phenomena peculiar to each. It forms with them neutral ſalts with metallic baſes capable of cryſtallizing; to all which ſalts M. Macquer thinks proper in his Courſe of Chemiſtry to give the general name of *vitriol*, and to ſpecify the different vitriols by the name of the metallic matters which enter into their compoſition.

Thus, for example, he propoſes to call the combination of vitriolic acid with ſilver, *vitriol of ſilver*, or *lunar vitriol*; and the combination of the ſame acid with mercury, *vitriol of mercury*, &c. in the ſame manner as the neutral metallic ſalts formed by the union of vitriolic acid with iron, and with copper, are called *vitriol of copper*, and *vitriol of iron*, or *martial vitriol*. *See* VITRIOL.

This acid, in conſequence of its great affinity with the inflammable principle, attacks the phlogiſton of metals when it diſſolves them, and ſeparates part of it from thoſe which are capable of being deprived of it; conſequently it calcines them more or leſs according to their nature, and to the manner of making the ſolution, and adheres to them proportionably leſs, as it has taken from them a greater quantity of their phlogiſton. We may conclude from theſe phenomena, that vitriolic acid diſſolves metals, chiefly by means of their phlogiſton; or that this principle is a medium of union between this acid and metallic earths.

The moſt general phenomena accompanying the ſolutions of metallic matters in vitriolic acid by the humid method, are, 1. The effervefcence and heat, which are commonly moderate. 2. The vapors; many of which are the volatile vitriolic acid, as in the ſolution of mercury; or they are inflammable vapors, as in the ſolution of iron. 3. The formation of concrete ſulphur, as in the ſolution of tin. *See the particular details of all the ſolutions of metallic matters by vitriolic acid, under the article of each metallic ſubſtance, and at the word* VITRIOL. *(q)*

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(q) Diluted vitriolic acid diſſolves iron and zinc ſpeedily, and copper very ſlowly. Boiling concentrated vitriolic acid diſſolves copper, and partly diſſolves and partly corrodes ſilver, tin, mercury, and lead. Vitriolic acid does not diſſolve gold, but precipitates it from aqua regia. It leſſens the volatility of mercury and of arſenic; and the fuſibility of lead, zinc, biſmuth, and regulus of antimony, when combined with theſe metallic ſubſtances. It diſſolves the calxes of moſt metals. It alſo diſſolves the regulus of cobalt, but not nickel.

Although vitriolic acid has a ſtrong power to combine with iron, yet its adheſion to it when diſſolved ſeems to be very weak. Thus Mr. Margraaf found, that by boiling a ſolution of green vitriol in a copper veſſel, or with filings of copper, part of the iron was depoſited, and in its place part of the copper was diſſolved. This experiment is ſo much more remarkable, as a diluted vitriolic acid has no ſenſible effect upon copper in a ſhort time.

It appears from what has been ſaid on the combinations of vitriolic acid with all the ſubſtances with which it can form a neutral ſalt, that all theſe neutral vitriolic ſalts are ſuſceptible of cryſtallization. This property is peculiar to vitriolic acid, and probably proceeds from the intimacy of union contracted betwixt this acid and the ſubſtances which it diſſolves.

Concentrated vitriolic acid acts with conſiderable force on oils and concrete oily matters. It boils and grows warm when added to them. It partly decompoſes them, blackens, and in ſome ſort burns them. From theſe mixtures many fumes exhale, which have a mixed ſmell of burnt oil, and of very ſuffocating volatile vitriolic acid. *See the detail and explanation of the phenomena at the word* OIL.

Vitriolic acid, when very weak, does not appear to have any action upon oils, becauſe its ſuperfluous water, with which it ſtrongly adheres, hinders it from combining with theſe ſubſtances, to which the water cannot be united. However, the union of ſuch a weak vitriolic acid with oil, does not ſeem impoſſible. *See* OIL.

The mixture of concentrated vitriolic acid with ſpirit of wine, ſhews many very intereſting phenomena, which vary according to the proportions of theſe two acids, and the management employed.

Without diſtillation, it entirely combines in ſubſtance with ſpirit of wine, without occaſioning any decompoſition; that is to ſay, it does not combine with any of the principles of the ſpirit of wine preferably to the reſt. It loſes its acidity by this union, and is rendered greatly milder. Hence

time. The acid therefore by its previous ſolution of iron ſeems to have been ſo changed, as to be rendered capable of diſſolving copper. This experiment does not contradict the general rule by which the power of union of vitriolic acid is affirmed to be greater to iron than to copper, but may be explained from the ſlight adheſion of the inflammable principle to the earth of iron; by which property, ſalts formed by this metal with vitriolic or nitrous acids are continually decompoſing; the phlogiſton of iron, eſcaping into the air or combining with the acid, and its calx ſeparating from the acid, in form of a red ſediment. This decompoſition of martial vitriol, and martial nitre, and alſo of ſome other metallic ſalts ſubject to the ſame change, is accelerated by application of heat, air, moiſture, and, as Mr. Margraaf's experiment ſeems to indicate, by the application of another metal, as copper.

it is called *Dulcified Vitriolic Acid.* It has alſo been called WATER *of* RABEL; which *ſee.*

When ſpirit of wine and vitriolic acid are diſtilled together, the latter decompoſes the former, takes poſſeſſion of its aqueous principle, reduces a part of it into a middle ſubſtance betwixt ardent ſpirits and oil, to which the name *Ether* has been given; and laſtly, the acid reduces the ſpirit of wine into a true oil, which has been improperly called *Sweet Oil of Vitriol. See the words* SPIRIT (ARDENT); ETHER; ETHER (VITRIOLIC); *and* SWEET OIL *of* VITRIOL.

Vitriolic acid is no where in nature found pure; that is, unmixed with any other matter. This proceeds from its capacity to diſſolve, and to combine with a great variety of different ſubſtances.

Thus vitriolic acid is found naturally combined, 1. With an inflammable ſubſtance; then it is in form of ſulphur or bitumen; or, 2. With earthy ſubſtances, in form of ſelenites, aluminous and argillaceous matters; or, 3. With metallic ſubſtances, in form of native vitriols; or, 4. With alkaline ſalts, in form of neutral vitriolic ſalts, with alkaline baſes. But it is almoſt only with the foſſile or marine alkali that the vitriolic acid is ever found naturally combined, becauſe this alkali is moſt generally diffuſed, and is indeed almoſt the only native alkali. Vitriolic acid is therefore found in form of Glauber's ſalt. Glauber's ſalt is chiefly found in thoſe waters which contain common ſalt. *See* SALT (COMMON), *and* WATERS *of* SALT FOUNTAINS.

Vitriolic acid, combined with vegetable fixed alkali, forming vitriolated tartar; or with volatile alkali, forming vitriolic ammoniac ſalt, otherwiſe called the ſecret ammoniac ſalt of Glauber; are found very rarely, and are produced by particular decompoſitions and combinations; as, for example, by burnings.

From what has been ſaid concerning the ſtates in which vitriolic acid is naturally and habitually found, we may perceive that it cannot be obtained alone and pure without particular artful operations; that is, by decompoſing thoſe bodies which contain moſt of it, and from which it may be moſt eaſily procured. Theſe bodies are *Sulphur* and *Vitriols. See theſe words for the extraction of Vitriolic Acid.*

Upon conſidering the ſeveral ſubſtances with which vitriolic acid is found naturally combined, an intereſting queſtion ariſes concerning the original and primitive ſtate of this acid. For as ſulphur is ſpread in very large quantities within the earth, and as by burning or decompoſition, its acid ſeparated from its phlogiſton becomes capable of combination with earthy and metallic ſubſtances (as happens actually in the fabrication of vitriols and of alum); we may conſider whether all vitriolic acid has been originally in the ſtate of ſulphur; and a part of this ſulphur being conſumed or decompoſed by natural cauſes, as happens in volcanos, its acid has formed all the vitriols and vitriolic ſalts with earthy baſes, which are found formed in the earth; or whether, (as we know by the experiment of the artificial compoſition of ſulphur, that vitriolic acid quits every other ſubſtance in order to combine with phlogiſton) all this acid was originally combined with earthy and metallic ſubſtances; and theſe vitriolic ſalts, meeting matters abounding in phlogiſton, have been decompoſed to form all the ſulphur found in the earth. This queſtion cannot certainly be decided but by the profoundeſt reſearches into the natural hiſtory of theſe ſeveral bodies.

The affinities of vitriolic acid according to Mr. Geoffroy's Table are, phlogiſton, fixed alkali, volatile alkali, earths, iron, copper, and ſilver: and according to Mr. Gellert's Table, phlogiſton, fixed alkali, volatile alkali, earths, zinc, iron, copper, ſilver, tin, lead, mercury, biſmuth, regulus of antimony, and of arſenic.

ACIDS (VOLATILE). Thoſe acids are ſo called which are more volatile than moſt other acids; which volatility proceeds either from an union of ſome phlogiſton, or of ſome attenuated oil. Such are the volatile vitriolic acid; the acid ſpirits of ſome acrid vegetables, as the roots of ſquills, according to Mr. Cartheuſer; the acids which riſe when butter or fat are diſtilled; and others ſimilar.

ACIDUM PINGUE. (r)

(r) ACIDUM PINGUE. Frederic Meyer, an Apothecary of Oſnaburg, publiſhed in the year 1764, a treatiſe concerning *Quicklime*, in which he endeavoured to explain the cauſticity of that ſubſtance, and alſo many other phenomena of chemiſtry, by means of a new principle which he pretended to have diſcovered, and to which he has given the name of *Acidum pingue*. Dr. Black had before that time publiſhed an account of experiments made upon Quicklime and Magneſia, which proved in the cleareſt manner that the cauſticity of quicklime, its ſolubility in water, and its

ADEPT is the name aſſumed by thoſe alchemiſts who pretended to have diſcovered the philoſopher's ſtone. *See* STONE (PHILOSOPHER'S).

ADOPTER.

diſſolving power, are original properties of pure uncombined calcareous earth; and that the want of theſe properties in lime-ſtone, marble, and other native earths capable of being converted by calcination into quicklime, depends on thoſe earths being always combined in their native ſtate with the fluid which has been called *fixed air*. Nevertheleſs, Meyer's theory, in the framing of which more imagination was employed than judgment, and more pains were taken to apply it to the explanation of phenomena than to prove its foundation on truth, has been adopted by many, eſpecially by German Chemiſts, and warmly defended by *Crantz*, *Fourchy*, and others. Dr. Black's doctrine has been very ably defended, and his experiments repeated and confirmed, by Mr. *Jaquin*, in a Treatiſe called *Examen Chemicum doctrinæ Meyerianæ de acido pingui et Blackianæ de aëre fixo reſpectu calcis. Vindobonæ*, 1769. In the following abſtract of Meyer's doctrine, the readers converſant in modern chemiſtry will eaſily perceive that he attributes to his *acidum pingue*, various effects, ſome of which are generally attributed to phlogiſton, others to the gas or fluid called fixed air, and laſtly, others to the abſence of this fluid,

Meyer maintains that the ſaline cauſtic quality of quicklime depends upon a peculiar ſubſtance, which he ſuppoſes is imbibed by the calcareous earth from the fire during its calcination. To this ſubſtance he gives the appellation *cauſticum et acidum pingue*. He thinks that it is compoſed of an acid, and of the pure principle of fire or matter of light; that it is a ſubtle elaſtic volatile matter (although it is fixed in quicklime); is analagous to ſulphur, and is indeſtructible. He infers that an acid exiſts in this principle: 1. From the ſolubility of quicklime in water, which he ſuppoſes can be effected only by an acid. 2. From the precipitation occaſioned in lime-water by adding an alkali, with which he ſuppoſes that his acid unites, while it leaves the earth. 3. From the change of properties and neutralization which the alkali ſuffers by its union with this acid, as the alkali then ceaſes to effervefce. That this acid principle is not a *pure* acid, he infers from its property of uniting with ſulphur, oils, and calcareous earths, which ſhew that the acid is united with ſomething fat or oily. This fat ingredient in his acid principle prevents the acidity of its taſte, and alſo prevents it from forming a neutral ſalt with alkalis, which, however, are ſo far changed by their union with the *acidum pingue*, that they are rendered ſoluble in ſpirit of wine, and capable of acting upon other oily ſubſtances which they could not unite with in their mild ſtate.

ADOPTER. *See* Receiver.

AFFINITY. By affinity *(s)* is underſtood that tendency which the conſtituent or integrant parts of bodies have to unite, and that power by which they adhere when united.

The definition of affinity ſhews that it is not a word void of meaning. The power with which the parts of bodies tend to unite with each other, and their adheſion when united, are very ſenſible and palpable effects, ſince this

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The acidum pingue is ſo ſubtle that it pervades red-hot veſſels, and combines with the bodies contained in them. It may be thus made to unite with metallic calxes, to which it imparts the greater weight which theſe bodies have than the metallic ſubſtances whence they were produced. It may be conveyed from theſe calxes by fire into alkalis, which thereby receive a cauſtic quality. It unites with the vitriolic acid, when this acid is diſtilled with ſpirit of wine or other inflammable matters, or when vitriol is diſtilled in a cracked veſſel, and forms the volatile ſulphureous acid. The acidum pingue exiſts naturally in the ſulphureous caverns of Puzzoli, Pyrmont, &c.

Meyer's treatiſe is tranſlated from the German into French by *M. Dreux*, under the title of *Eſſais de Chymie ſur la chaux vive*, 2 vols. 12mo.

(s) By the terms *affinity* and *elective attraction*, we ought to underſtand the power by which the conſtituent parts of bodies unite, and not to ſuppoſe that this power is exerted by any ſimilarity and homogeneity of parts, or by any mechanical traction, as theſe terms ſeem to imply. The cauſe of this power, or the manner in which this union of conſtituent parts, is produced, is unknown to us. To theſe terms, therefore, another leſs exceptionable, namely, *the power of combination*, may be ſubſtituted. In our author's definition of affinity are comprehended not only the power by which the conſtituent parts of bodies unite, which is the proper object of chemiſtry; but alſo, the power by which the integrant parts unite, which he calls the affinity of aggregation, and which is treated of by writers on natural philoſophy and mechanics under the terms attraction, gravitation, and coheſion. Whether theſe two kinds of union are produced from the ſame cauſe differently modified, as our author thinks, I know not; but their effects are ſo different, that they deſerve to be conſidered ſeparately: the union of integrant parts being only an appoſition of theſe parts, which are capable of being disjoined by mechanical means, and without any change produced upon their properties; and the union of conſtituent parts, or combination, being attended with conſiderable changes of properties, and being incapable of disjunction by mechanical means. *See the article* Composition *of* Bodies, and the following *Note.*

power cannot be deſtroyed but by another power as real and more conſiderable. It is beſides demonſtrated by numberleſs experiments; as, for example, by the adheſion of two bodies applied to each other, whoſe ſurfaces are finely poliſhed; by the tendency which two drops of water, or of oil, mercury, or of any other fluid, have to run together and unite into one maſs; by the convex or ſpherical figure which drops of fluids aſſume, when their form is not given them by containing veſſels or other body, and when they are ſupported by bodies with which they are not diſpoſed to unite: all which effects happen even in a vacuum, and demonſtrate the affinity which the integrant parts of bodies ſolid, or fluid, have to each other.

The affinity of the conſtituent parts or principles is demonſtrated by the detail of all the phenomena in chemiſtry.

We do not here enquire into the cauſe of this great effect, which is ſo general, that it may itſelf be conſidered as the cauſe of all combinations, and may ſerve to explain them. It may perhaps be a property as eſſential to matter as its extent and impenetrability, of which we can ſay no more, than that ſuch properties do exiſt. On this ſubject the works of Newton, Freind, Keil, and the Abbé Marcuzzi, may be conſulted. Theſe authors have endeavoured to illuſtrate theſe obſcure ſubjects by calculation. We ſhall be ſatisfied with obſerving the moſt remarkable laws, according to which the principles of bodies unite and combine, in conſequence of this property.

M. Macquer diſtinguiſhes ſeveral ſorts of affinities. Not that he believes there are really different ſpecies of affinities; for it is very certain, that it is but one and the ſame property of matter, differently modified according to different circumſtances; but only that he may better diſtinguiſh and remark the phenomena occaſioned by this property, in the detail of the combinations and ſeparations which it effects in the moſt general and moſt important operations of chemiſtry.

By *ſimple affinity* he means the diſpoſition to unite and adhere, which is obſerved between the integrant and homogeneous parts of the ſame body, or between the heterogeneous parts of two different bodies. The ſimple affinity is therefore diſtinguiſhed into two kinds.

The firſt kind of ſimple affinity produces the *union of aggregation*; that is to ſay, that the body reſulting from this union is of the ſame nature, but of larger ſize. M. Macquer calls it the *affinity of aggregation*; as, for example, when ſeveral looſe particles of the ſame metal or of the ſame earth are united together by fuſion, ſo as to form but one maſs. *See* AGGREGATION.

The ſecond kind of ſimple affinity, producing the union and adherence of heterogeneous parts, different in their natures, from which reſults a new compound body, whoſe properties are different from thoſe of the two principles from which it was formed, is called *affinity of compoſition*; becauſe a new body is actually compoſed. If, for example, the primitive integrant parts of vitriolic acid be united with thoſe of iron, a new body reſults from this union, which is neither vitriolic acid nor iron, but a compound of the two, called *martial vitriol.*

The following remarks may be made on ſimple affinities.

1. That the affinity of aggregation reſiſts the affinity of compoſition. For it is evident that the force which makes the homogeneous and integrant parts of a body adhere together, hinders them from ſeparating, in order to join the parts of another body.

2. Hence it follows, that if the adheſion of aggregation betwixt the integrant parts of a body be weakened or deſtroyed, the affinity of compoſition is thereby facilitated; that is, the affinity which they have to join the parts of another body.

3. That as the hardneſs of a body ſuppoſed ſimple and homogeneous depends only on the adheſion of aggregation betwixt its integrant parts, if this adheſion be deſtroyed by ſeparating theſe parts from each other; as by reducing them into fine powder, or ſtill more by diffuſing them in a liquid, with which they have no adheſion, or leſs than they had to each other; they may then be combined with the parts of another body, more or leſs eaſily, in proportion as they have been more or leſs ſeparated by this mechanical diviſion.

4. As different bodies are more or leſs ſuſceptible of this mechanical diviſion, whether artificial or natural, by which their integrant parts are more or leſs ſeparated from each other, hence ariſes great difference betwixt theſe bodies in their greater or leſs facility of combining with other bodies.

5. The facility with which one body combines with another does not, however, ſolely determine the degree of affinity betwixt theſe two bodies. For experience ſhews that the principles or conſtituent parts of certain compounds, which unite together very readily and eaſily, have however but a weak adheſion, which is deſtroyed by the ſmalleſt effort of analyſis, or chemical decompoſition; while other principles which can be united only with great difficulty, and by ſtudied means, contract together an union much

ſtronger, and much leſs apt to be diſſolved. Mercury, for inſtance, unites much more eaſily with nitrous acid than with the marine, but yet it adheres much more ſtrongly to the latter than to the former.

Hence we ought to conclude, that we cannot poſitively determine that one body has no affinity with another body, becauſe no means are known of uniting them. On the contrary, it appears certain that all natural bodies have a certain degree of affinity, and of facility of uniting with each other, and a certain degree of adheſion when they are united, and conſequently, that there are no combinations really and abſolutely impoſſible; but that this degree of affinity varies according to the different ſtates in which theſe bodies are found.

However, as the want of union betwixt two bodies prevents their affinity from ſhewing itſelf, we may conſider thoſe bodies which we cannot combine as if they had no affinity together, until chemiſtry be ſo far advanced as to make combinations which now ſeem impoſſible. Thus, for inſtance, oil is ſaid to have no affinity with water, nor lead with iron, nor iron with mercury; becauſe, in fact, theſe bodies cannot be directly united together in chemical operations. Thus any affinity which they may have to each other is to us of no conſequence.

On the contrary, as the affinities of bodies which may be united together, produce in chemical operations effects proportionable to their facility of union, and to their force of adheſion when united, we may conſider the affinity of bodies in general, as being in a compound ratio of theſe two properties.

The laſt remark we can make on the ſimple affinity of compoſition, furniſhes a very uſeful and very general fundamental law, by which we may diſcover, even without decompoſition, the principles of which bodies are compoſed. The remark is, that all compound bodies have properties partaking of the properties of the principles of which theſe bodies are compoſed. Thus, for example, the union of two principles, of which one is fixed, and the other is volatile, forms a compound, whoſe degree of fixity or volatility is intermediate betwixt thoſe of the two principles.

The ſame may be ſaid of all the other properties; ſuch as gravity, opacity, tranſparency, ductility, hardneſs, fluidity, &c. and even of the affinities: ſo that, ſuppoſing we knew perfectly the properties of the principles of a compound, we might, by examining the properties of this compound, diſcover its principles, even although its analyſis were impoſſible.

We muſt however allow that this rule, although very general, is ſubject to a conſiderable number of reſtrictions and modifications, which depend on a number of particular circumſtances. For example: it happens ſometimes that the operation by which two principles are united changes or even annuls ſome of the properties of theſe principles: it happens too that ſometimes their union developes new properties, which cannot be immediately perceived in either of the principles. But ſuch changes are never ſo compleat as to lead one into groſs miſtakes concerning the principles; therefore they do not prevent the rule from being ſufficiently general, to be an excellent guide in many chemical enquiries. (*t*).

Where more than two bodies act upon one another, the *affinity* may be called *complicated*; and from the definition given, it appears that all theſe complicated affinities muſt be of the kind called *Affinity of Compoſition.*

Firſt, we ought to conſider that complicated affinity in which only three principles act. Experience indicates the following obſervations.

If a principle be added to two other principles united to-

(*t*) The rule mentioned in the text is ſo far from being general, that perhaps the reverſe of it may be conſidered as a general rule; and a change of properties, and a production of new properties, may be conſidered as criterions, by which compound bodies, chemically combined, may be diſtinguiſhed from bodies formed merely by mixture or appoſition of integrant parts; in which latter kind of bodies, the properties are intermediate betwixt the properties of the ſeveral component parts, and no new properties are produced. Thus, three parts of copper combined by fuſion with one part of tin, forms a body more hard, more brittle, and more ſonorous, than either of the conſtituent metals. Its hardneſs, therefore, its brittleneſs, and its ſonorouſneſs may be conſidered as new properties. Its color is much whiter than the intermediate color, and its ſpecific gravity is greater than the intermediate ſpecific gravity. Further, the properties of bodies are in many inſtances deſtroyed or annulled by chemical combination. Thus the acrimony and deliqueſcency of acids and of alkalies are almoſt entirely annulled by combining theſe two kinds of ſubſtances together. Every body chemically combined may furniſh facts which refute the general propoſition mentioned in the text. Bodies formed by mixing, not by chemically combining ſeveral ſubſtances together; as, for inſtance, a liquor formed by mixing wine and water; partake of the qualities of each ingredient, proportionably to the quantity of it employed. *See* COMPOSITION *of* BODIES, *and* AGGREGATION.

gether, phenomena of compoſition or of decompoſition happen, which differ according to the affinities of theſe three bodies to each other.

1. Sometimes the third ſupervening principle is united to the other two, and forms together with them a compound conſiſting of three principles. For example, if to a maſs compoſed of gold and ſilver ſome copper be added, this third metal is united to the other two, and forms with them a compound conſiſting of three principles, namely, gold, ſilver, and copper. Thus it happens, when the third ſupervening principle has with the two others an affinity equal, or almoſt equal to the affinity which theſe two principles have to each other.

2. The ſame thing alſo happens ſometimes, although the third ſupervening principle has no affinity with one of the two principles originally united. But then it is neceſſary that this ſupervening principle ſhould have, with the other of the two principles, an affinity equal to the affinity ſubſiſting between thoſe two principles originally united. And in this caſe, that principle which ſerves to connect and unite the two which could not otherwiſe be united, is called an *intermedium.* This affinity may alſo be called the *affinity of intermediums.* For example, if water be added to the compound called *liver of ſulphur*, which conſiſts of two principles, ſulphur and fixed alkali, it unites with the water, diſſolves in it without being decompoſed, and forms a new compound conſiſting of three principles, namely, ſulphur, fixed alkali, and water. The water and ſulphur could not by themſelves form any union: but as fixed alkali has a great affinity with both ſulphur and water, it ſerves upon this occaſion as an intermedium to unite theſe two ſubſtances together. It is neceſſary to remark, that in this affinity of intermediums, the affinity of the principle which ſerves as an intermedium is weakened, becauſe it is divided betwixt two bodies; and that the union contracted with them is leſs ſtrong than if it were united to one of them only.

3. Sometimes a third principle, when added to a compound conſiſting of two principles, does not unite but with one of theſe two principles, and obliges the other to ſeparate itſelf entirely from the principle with which it was originally united. In this caſe a total decompoſition happens of the firſt compound, and a new combination of the remaining principle with the ſupervening principle; from which a new compound reſults. This happens when the ſupervening

principle has little or no affinity with one of the principles of the compound; and when it has with the other, an affinity much ſtronger than that which ſubſiſts betwixt the two firſt principles. For example, when an alkali is added to a ſolution of a metallic matter in an acid, as it has more affinity with the acid than with the metal, it ſeizes the acid, and obliges it to quit the metal, which therefore precipitates; becauſe the metal has much leſs affinity than the alkaline ſalt has to the acid.

4. It happens ſometimes that a principle, which, in conſequence of the affinity we have been diſcourſing of, has been ſeparated from another principle, may again reſume its place with the principle, as it was originally, and diſpoſſeſs the ſupervening principle. This affinity, which is called *reciprocal*, on account of its reciprocal effects, takes place when the two principles which are alternately ſeparated from the third principle by each other, have with this third principle an almoſt equal affinity, and that their ſeparation is procured by particular circumſtances relative to ſome of their properties.

All that has been ſaid concerning the affinities of three principles may be applied to affinities of four principles, due regard being had to the changes produced by the introduction of a fourth principle. It is evident, for example, that in place of one decompoſition and one new compoſition, which can reſult from the different degrees of affinity of three principles, the affinities of four principles forming two new compounds, may, by a mutual change, produce two decompoſitions and two new combinations. This always happens when the ſum of the affinities, which each of the principles of the two compounds has with the principles of the other, ſurpaſſes the ſum of the affinities ſubſiſting betwixt the principles forming the two firſt compounds. This ſort of affinity, where there is a double exchange of principles, may be called *double affinity*. Examples of theſe affinities are often met in chemical operations and mixtures; and without a knowledge of them, it would be impoſſible to explain many ſingular phenomena of decompoſition. For example, it happens often that two principles, neither of which could ſingly effect the diſunion of the principles of a compound, becauſe their affinities are each of them inferior to the affinity betwixt the principles of that compound, become nevertheleſs capable of procuring this decompoſition when they act in concurrence. For this purpoſe, it is ſufficient, as we have already ſaid, that the ſum of affinities which the two decompoſing principles have with the principles of the body to be decompoſed, ſhould ſurpaſs the ſum of the affinity betwixt the principles of the decompoſing body, and of the affinity betwixt the principles of the body to be decompoſed. *See examples of this play of affinities at the words* BLUE (PRUSSIAN), *and* SALT (NEUTRAL ARSENICAL).

We ſhall purſue no farther theſe remarks upon affinities; becauſe the affinities of bodies compounded of many principles are much leſs ſtrong and leſs ſenſible in chemical operations; or becauſe this ſcience is not yet ſufficiently advanced to have obſerved and diſtinguiſhed them all. What we have ſaid is ſufficient to form juſt ideas on the theory of all the important phenomena which are exhibited by the fundamental experiments, and to conduct to many new diſcoveries. *See the annexed* TABLES *of* AFFINITIES, *with their* EXPLANATION. *(u)*

AGARIC.

(u) Although many of the affinities contained in theſe Tables are mentioned under the ſeveral articles of the ſubſtances to which they relate, in the following Dictionary, yet I thought it might be uſeful to place them in one view, as they are given by their authors *Geoffroy* and *Gellert.*

EXPLANATION OF THE TABLES OF AFFINITIES.

Each of theſe Tables conſiſts of a number of columns. At the head of each column is placed the ſubſtance, the affinities of which are to be compared with the ſeveral ſubſtances placed below it in the ſame column. Thus the firſt column of Mr. Geoffroy's Table contains the Affinities of *acid ſpirits*; the ſecond column contains the Affinities of *marine acid*, &c. The remaining ſubſtances in the firſt column, as *fixed alkali*, *volatile alkali*, &c. are thoſe, the affinities of which with acid ſpirits are to be compared together: and they are ſo diſpoſed, that the ſubſtance which has the ſtrongeſt affinity with *acid ſpirits* is placed neareſt to them, and the ſubſtance which has the leaſt affinity with acids is placed at the greateſt diſtance; while the ſtrength of the affinity of the intermediate ſubſtances may be known by their vicinity to the head of the column. Thus, acid ſpirits have a ſtronger affinity to fixed alkali than to volatile alkali, abſorbent earths, or metallic ſubſtances: alſo, they have a ſtronger affinity to volatile alkali than to abſorbent earths; and laſtly, they have a ſtronger affinity to abſorbent earths than to metallic ſubſtances.

Mr. Gellert has (in his original Table) inverted this order, placing thoſe ſubſtances at the greateſt diſtance, or at the bottom of the columns, which have the ſtrongeſt affinity with thoſe at the head of the columns. But as this difference in the order of the two Tables might create ſome confuſion, I have changed this diſpoſition of Mr. Gellert's Table, and have made it correſpond with that of Mr. Geoffroy which is above-deſcribed.

According to the doctrine of affinities delivered under the article AFFINITY of this Dictionary, any ſubſtance in any of theſe columns may be ſeparated from the ſubſtance at the head of that column by any of the intervening ſubſtances. Thus, according to the firſt column of Mr. Geoffroy's Table, if any *metallic ſubſtance* be united with an acid ſpirit, it may be ſeparated from that ſpirit, by adding either an abſorbent earth, or a volatile alkali, or a fixed alkali: ſecondly, if an abſorbent earth be united with an acid ſpirit, it may be ſeparated from that ſpirit, by adding either a volatile or fixed alkali: and laſtly, if a volatile alkali be united with an acid ſpirit, it may be ſeparated from that acid by adding a fixed alkali.

To explain the uſe of theſe Tables ſtill further, I ſhall give an inſtance of the affinities of *ſulphur*, as they are expreſſed in Mr. Gellert's Table.

If ſulphur be united with regulus of cobalt *, with which, according to this Table, it has leſs affinity than with any of the ſubſtances mentioned in this column, and if to this compound arſenic be added; by ſublimation the ſulphur will be ſeparated from the regulus of cobalt, and will be united with the arſenic, forming a ſublimate called *orpiment*.

If to this orpiment an equal quantity of mercury be added, and if the mixture, after it has been well triturated, be expoſed to heat in a retort, or other cloſe veſſel, the arſenic will be ſeparated from the ſulphur, and will form a white ſublimate; while the ſulphur and mercury will unite, and be afterwards ſublimed together, forming a cinnabar.

If to this cinnabar a third part of regulus of antimony be added, and the mixture be expoſed to heat in a retort, the mercury will be diſtilled, and the ſulphur will remain united with the regulus, forming a compound ſimilar to native antimony.

If to this artificial, or to native antimony fuſed in a crucible, half its quantity of biſmuth be added, this ſemi-metal will unite with the ſulphur of the antimony; while the regulus of the antimony will be ſeparated, and form a diſtinct maſs at the bottom of the crucible.

If this compound of biſmuth and ſulphur be melted with an equal quantity of ſilver, the biſmuth will be ſeparated from the ſulphur, which will unite with the ſilver, forming a maſs ſimilar to the vitreous ſilver-ore.

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* In the Table it is marked *cobalt*; but Mr. Gellert evidently means the *regulus of cobalt*; for the ore properly called Cobalt, contains various ſubſtances, each of which has peculiar affinities. *See* COBALT.

If this maſs, or the vitreous ore, be melted with half its quantity of lead, the ſilver will be ſeparated from the ſulphur, which will unite with the lead, forming a maſs reſembling the lead-ore called galena.

If this ſulphurated lead be melted with tin, the lead will be ſeparated, and the tin will be united with the ſulphur.

In the ſame manner, the ſulphur may be transferred from the tin to copper; and from copper to iron.

The affinities of bodies to each other, as they are laid down in the above Tables, or at leaſt the ſeparations and decompoſitions depending upon the differences of affinities, do not at all times take place; ſome of them requiring certain degrees of heat, dilution, and various other circumſtances. Many inſtances do alſo occur, in which the affinities of ſubſtances ſeem even to be changed by theſe different circumſtances; and hence many exceptions have been found to the preſent Tables, ſome of which are real, and others only apparent. Thus, in the firſt column of Mr. Geoffroy's Table, metallic ſubſtances are placed as having a leſs affinity than abſorbent earths with acids. Nevertheleſs, ſome inſtances occur of earthy ſalts, as alum, being decompoſed by means of metals, as of iron, zinc, and copper. Here therefore we find a real exception to this Table. Again, abſorbent earths are placed as having leſs affinity than volatile alkali with acids. But the volatile alkali of ſal ammoniac may be ſeparated from the acid, by means of chalk or quicklime; which ſeems to ſhew, that ſome abſorbent earths have a greater affinity with acids than volatile alkali. This alkali does indeed, when it is mild, precipitate a ſolution of any calcareous earth in any acid; and this experiment has probably induced Mr. Geoffroy to place theſe ſubſtances in their preſent order. But the above mentioned precipitation is now known to be effected by what Mr. Macquer calls a double affinity. For the mild alkali, conſiſting of pure alkali and fixable air or gas, is here to be conſidered as a compound: and when it is added to a ſolution of calcareous earth in any acid, the gas unites with the earth, to which it has a greater affinity than to the alkali, while the acid unites with the alkali. That this is the caſe, in the preſent inſtance, appears from the impoſſibility of precipitating this earth from the acid by means of a cauſtic volatile alkali, that is, an alkali which is not combined with gas. Many other inſtances might be adduced of the inaccuracies and defects of theſe Tables, and of the apparent variations from the general rules laid down in them; but as all chemical compoſitions and decompoſitions depend on the affinities of the ſubſtances employed, we cannot explain and correct theſe, without conſidering almoſt all the operations in Chemiſtry. Till other Tables more perfect be formed, theſe may be of conſiderable utility.

AGARIC. (x)

AGATE. (y)

AGGREGATION. In order to have a clear idea of what chemiſts mean by the words *aggregation*, *aggregate*, *aggregated bodies*, we muſt attend to the difference betwixt what natural philoſophers call *conſtituent parts* and *integrant parts* of bodies. The conſtituent parts are, properly ſpeaking, the principles of bodies. Theſe are ſubſtances differing

(x) Agaric is a fungus growing on the trunk of the common larch tree, from which turpentine is obtained. Three-fourths of it is a reſinous ſubſtance, and the remainder is a ſlimy mucilaginous earthy matter, ſo tenacious as ſcarcely by any method to be diſſolved by water.

(y) Agate is a flint variegated with different colors blended together, and ſometimes with colored lines and dendritical figures, as the *mocha ſtone*, which is a variety of agate, or with red ſpots, as the *ſardea* or *St Stephen's gem*, which alſo are varieties of this ſtone For the chemical properties of agates, *ſee* Earths (Vitrifiable). By fire the *color* of a white agate, called *chalcedony*, was rendered whiter, and the color of a black agate was not changed. Colors may be given to agates, or their natural colors may be changed. Mr. du Fay, in the Memoirs of the Academy of Sciences, 1728, relates, that to chalcedony a ſaturated ſolution of ſilver in ſtrong ſpirit of nitre gave a reddiſh brown color, to oriental agate a blacker ſtain, and changed the yellow ſpots of an agate to purple. The ſtone after the application of the metallic ſolution ought to be placed in the ſun; and the color may be rendered more intenſe by repeating the application of the ſolution. The liquor ſpreads ſo much on the ſtone, that neat deſigns cannot be made on it. Dr. Lewis propoſes to remedy this inconvenience by covering the ſtone over with etching wax, and the lines intended to be ſtained cut through this ground, in the manner of etching copper-plates. The colors given to theſe ſtones may be deſtroyed by fire or by aqua fortis; and the colors thus deſtoroyed by aqua fortis are recoverable by expoſure to the ſun. Agates and other ſtones may be ſtained black by applying to them a ſolution of copper in aqua fortis, and afterwards expoſing them to a red heat in a crucible. See *Lewis's Commerce of Arts*. Mocha ſtones may be imitated by moiſtening the ſmooth ſurface of an agate with the ſolution of copper, and on the middle of this ſurface ſetting an iron nail upright on its head. The iron abſorbs the acid from the copper, and the copper forms ramifications. If the nail be then removed, and the corroded iron carefully waſhed off by dipping the ſtone in water, the vegetations may be rendered by a red heat of a black color. Theſe vegetations are not fixed in the ſtone, which ought therefore to be covered with a plate of cryſtal glaſs.

in nature from each other, which, by their union and mutual combination, really *conſtitute* mixed bodies, which partake of the properties of their conſtituent parts. For example, the conſtituent parts of common ſalt are an acid and an alkali, which ought to be conſidered as the principles of this ſalt, at leaſt as its proximate principles. *See* PRINCIPLES. As this acid and alkali are what really conſtitute common ſalt, and are the parts, to the union of which it owes its exiſtence and properties, it is evident that the conſtituent parts cannot be diſunited from each other, without deſtroying and decompoſing it: ſo that after ſuch a diſunion, the ſalt will no longer exiſt, but only the acid and the alkali of the ſalt, which are very different from the ſalt, and from each other.

On the contrary, the *integrant parts* of bodies do not abſolutely differ from each other; nor do they differ, as to the nature and principles, from the body into whoſe maſs they enter. By the integrant parts of a body are to be underſtood the ſmalleſt molecules or particles into which this body can be reduced without decompoſition. We may conceive that a neutral ſalt, for inſtance, common ſalt, may be divided into molecules ſtill ſmaller and ſmaller, without any ſeparation of the acid and alkali which conſtitute the ſalt; ſo that theſe molecules, however ſmall, ſhall always be common ſalt, and poſſeſſed of all its eſſential properties. If we ſhould now ſuppoſe that theſe molecules are arrived at their utmoſt degree of ſmallneſs, ſo that each of them ſhall be compoſed of one atom of acid and of another atom of alkali, and that they cannot be further divided without a ſeparation of the acid and alkali, then theſe laſt molecules are thoſe which Mr. Macquer in his Chemical Lectures calls *primary integrant molecules.*

In the ſame manner that we conceive that a body may be divided into its primary integrant molecules, without any change of its nature, or other alteration than a diminution of its bulk; ſo we may alſo eaſily perceive, that if theſe primary integrant molecules, which are all homogeneous and of the ſame nature, and which are ſuppoſed ſeparated from each other, ſhould be brought to unite and combine together, no new body, that is, a body of different nature, will reſult from this union, but only a more conſiderable maſs of the ſame body: that is to ſay, for inſtance, that if the primary integrant molecules were common ſalt, their reunion would ſtill form common ſalt, only in a maſs ſo much larger, as there is a greater number of theſe molecules united together. But it is the union of theſe homogeneous parts, of theſe primitive integrant molecules, which modern chemiſts have called *aggregation*; and they have called *aggregates* bodies conſidered as reſulting from their primary integrant parts, in oppoſition to the names *mixt* and *compounds*, which they have given to bodies conſidered as reſulting from the union of their conſtituent parts, which are ſubſtances heterogeneous, and of different natures.

The name of integrant parts, which has been given to thoſe whoſe union forms aggregates, agrees well with them; becauſe, in fact, this union is a kind of addition or integration (if ſuch a word may be uſed) of a certain number of parts of the ſame kind, whence reſults a ſum, or a whole.

It is very eſſential to obſerve on the ſubject of aggregation, that we ſhould have a very falſe idea of it, and entirely oppoſite to chemical phenomena, if we underſtood by this word nothing but a ſimple juxtapoſition of the integrant parts of bodies: for beſides that, there muſt be a real adheſion and intimate union of theſe ſame parts with each other, ſo that they cannot be ſeparated but by ſome force ſuperior to that by which they are united. A heap of ſand, for example, if we conſider the grains of ſand as its integrant parts, cannot be regarded as an aggregate, becauſe theſe grains are only *juxtapoſited*, and have no real adheſion together; ſo that the reſiſtance which they oppoſe to their ſeparation can only proceed from their gravity, and is not the effect of adheſion, or tendency to each other.

In the ſecond place, it is neceſſary to obſerve on the ſubject of aggregation, that the force of adheſion of the integrant parts of different bodies varies much, according to the nature of theſe bodies, ſome of them adhering very ſtrongly, and others very weakly; and that thoſe which adhere weakly are generally the eaſieſt to be diſſolved, conſidering that the ſolution of a body, or its combination with another body of a different nature, cannot be effected but ſo far as the integrant parts of theſe bodies are ſeparated, or their aggregation is broken; which is partly done by the operations of art, but chiefly by the action of menſtruums.

All theſe conſiderations on the aggregation of bodies, although very ſimple in themſelves, are of the greateſt importance in the theory and practice of chemical operations. Becker and Stahl were the firſt who explained theſe ideas, which have been ſince illuſtrated and extended by the beſt modern chemiſts. *See the words*, AFFINITY, COMPOSITION, SOLUTION, DECOMPOSITION, DIVISION *of* BODIES.

AIR. Air is a fluid inviſible, inodorous, inſipid, imperceptible to all our ſenſes but the touch, and is conſidered as a ſimple elementary body, and primary principle, becauſe it cannot be altered or decompoſed by any known methods.

The air is always in form of a fluid, though perhaps that fluidity is not eſſential to it. But it is certain that no cold has ever yet been produced, natural or artificial, ſtrong enough to deprive it of its fluidity.

We cannot flatter ourſelves that we can have air, any more than the other elements, in perfect purity. On the contrary, it is always found mixed with more or leſs of foreign ſubſtances, proceeding from a perpetual exhalation of volatile matters, and particularly of water, with which it has even a certain degree of adheſion.

The primary integrant parts of air, although certainly very ſmall, yet are not ſo ſmall as thoſe of water, and even thoſe of other liquids leſs ſimple, ſuch as ſpirit of wine and oils: at leaſt, theſe liquids paſs eaſily enough through the pores of ſeveral ſubſtances, ſuch as paper, the ſkin, &c. through which the air does not paſs, or paſſes with difficulty.

The experiments of Mr. Boyle, and more particularly thoſe of Dr. Hales, related in his Vegetable Statics, prove that moſt vegetable and animal matters contain a prodigious quantity of air; and ſcarcely credible, if the effects it produced were not ſo conſiderable and ſenſible. Chemical experiments alſo give us many occaſions not only of obſerving theſe phenomena, but alſo of aſcertaining the quantity of air diſengaged, or abſorbed in ſeveral operations. *(z)*

It appears that air, as well as other primary principles, is found in bodies in two different ſtates: that is to ſay, that in certain bodies, and in certain circumſtances, it is merely diſperſed and interpoſed betwixt the integrant parts of thoſe bodies, but without adhering to theſe parts, or at leaſt adhering but very weakly. This air, which may be ſeparated by means purely mechanical; ſuch as the operations of the air-pump, compreſſion, or ſhaking; and which beſides poſſeſſes all its other properties, ought not to be conſidered as one of the elements of thoſe bodies in which it exiſts. But that portion of air which cannot be ſeparated

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(z) The permanently elaſtic fluids produced in diſtillations and other chemical operations are very different in many eſſential properties from atmoſpherical air. *See* GAS.

from many bodies but by analyſing them, and by employing ſuch means of decompoſition as chemiſtry furniſhes; which, beſides while it remains in thoſe bodies, is deprived of one of its eſſential properties, its elaſticity, which it does not recover till it is diſengaged; this air, I ſay, ought truly to be conſidered as one of the elements or conſtituent parts of theſe bodies.

The properties of pure air, and which occaſion many effects in chemiſtry, are:

1. Its *expanſive power*; that is to ſay, that it is capable of great rarefaction, and of occupying a ſpace thirteen times larger than its original ſize, when it is expoſed to the greateſt poſſible heat. This great expanſibility of air, added to the prodigious quantity of it which is diſengaged in many chemical analyſes and mixtures, occaſions frequently violent exploſions, againſt which an intelligent artiſt ought always to be on his guard. (*a*)

2. Its *compreſſibility*; that is to ſay, that the effect contrary to that we have been mentioning, is produced upon it by means of cold and of preſſure.

3. Its *elaſticity*; which is nothing elſe than the force with which it endeavours to reſume its natural condition, when it is violently rarefied, compreſſed, or condenſed; and the effort which it makes for that purpoſe upon bodies which oppoſe its re-eſtabliſhment.

4. Its *weight*; which determines it to fall impetuouſly into all the ſpaces into which it can have acceſs, and which are unoccupied by air, or more ponderous bodies. The experiments which demonſtrate all theſe properties of the air are ſo numerous and deciſive, that nothing is better known and illuſtrated in natural philoſophy. On this ſubject may be conſulted the works of Paſcal, Boyle, Mariotte, Abbé Nollet, and, in a word, of all the experimental philoſophers. It

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(*a*) Air is expanded ⅓ of its bulk by the heat of boiling water. *See the Hiſtory of the Academy of Sciences* 1699. Hales found that the air in a retort, when the bottom of the veſſel was juſt beginning to be red-hot, was expanded to twice its former ſpace, and in a white or almoſt melting heat it occupied thrice its former ſpace or more; and Mr. Robins, a very accurate experimental philoſopher, found that air was expanded by the heat of iron juſt beginning to be white to four times its ſize. As greater expanſions cannot be well eſtimated, I preſume there is an error in that part of the text to which this note refers, where the air is ſaid to be capable of expanſion to thirteen times its ordinary bulk.

is only neceſſary to obſerve here, that the ſpecific gravity of air is to that of water, nearly as 1 to 850.

5. The faculty which the air has of conſiderably *facilitating the evaporation* of volatile matters ſublimed by the fire. It is a well eſtabliſhed fact in chemiſtry, that the acceſs of air greatly accelerates all evaporations and diſtillations. We ſee, for example, that by directing the blaſt of bellows upon the ſurface of any volatile body evaporating by means of fire, as water, antimony, mercury, &c. that the ſmoke or vapors of theſe bodies are very ſenſibly encreaſed. It is alſo certain that any diſtillation of a liquor, as of water, is much haſtened, by directing upon its ſurface in the inner part of the alembic, the wind of a ventilator, as an Engliſh author has propoſed. *See* DISTILLATION *and* EVAPORATION.

6. Laſtly, the moſt ſingular property of air, and at the ſame time one of the moſt intereſting in chemiſtry, is, that no combuſtible ſubſtance can burn without its acceſs; and that the more ſtrongly it is impelled againſt burning bodies, the more rapid is the combuſtion. Hence it follows, that as moſt chemical operations cannot be performed without the aſſiſtance of fire, a conſtant current of air more or leſs ſtrong, and in a certain direction, is neceſſary to produce the heat requiſite in theſe operations. Theſe currents of air are procured by bellows applied either to a forge, or to a melting furnace; or they are procured merely by the conſtruction of the furnaces; which is done in ſuch a manner, that by means of a ſpace left in the upper part of the furnace, in which the heat keeps up a perpetual vacuum, the external air is determined and forced to enter by the aſh-hole, to fill the vacuum above, and conſequently forms a current which conſtantly paſſes through the fire, and which is ſo much more ſtrong and rapid as the vacuum of the furnace above is greater. That is a fundamental principle from which general rules may be deduced, applicable to the conſtruction of all poſſible furnaces. *See* BELLOWS, FORGE, *and* FURNACE.

Boerhaave, in his Treatiſe on Fire, and M. Geriké, Doctor of Phyſic, and Member of the Royal Academy of Berlin, who has alſo given a very large Diſſertation on Fire, in a very good work, printed in 1741, entitled *Fundamenta Chymiæ Rationalis*, are of opinion, that the acceſs of air is neceſſary to the combuſtion of ſubſtances; becauſe, by its weight and ſpring, it keeps the flame conſtantly applied to the combuſtible body, and encreaſes their contact.

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[*To be placed in Vol. I. facing the article* AFFINITY.

A TABLE OF THE SOLUTIONS OF BODIES, BY MR. GELLERT.

1. Siliceous Earth	2. Fluors	3. Clay	4. Earth Gypſeous	5. Earth Calcareous	6. Fixed Alkali	7. Volatile Alkali	8. Acetous Acid	9. Marine Acid	10. Nitrous Acid	11. Vitriolic Acid	12. Aqua Regia	13. Nitre	14. Sulphur	15. Hepar of Sulphur	16. obalt	17. Arſenic	18. Regulus of Antimony	19. Glaſs of Antimony	20. Biſmuth	21. Zinc	22. Lead	23. Tin	24. Iron	25. Copper	26. Silver	27. Mercury	28. Glaſs
Hepar of Sulphur *Fixed Alkali* *Borax* *Calx of Lead* *Calx of Antimony*	*Hepar of Sulphur* *Fixed Alkali* *Borax* *Calx of Lead* *Calx of Antimony* *Clay* *Earth Calcareous* *Earth Gypſeous*	*Vitriolic Acid* *partly* *Hepar of Sulphur* *Fixed Alkali* *Borax* *Calx of Lead* *Calx of Antimony*	*Acids* *partly* *Hepar of Sulphur* *Fixed Alkali* *Borax* *Calx of Lead* *Calx of Antimony*	*Vitriolic Acid* *Nitrous Acid* *Marine Acid* *Acetous Acid* *Hepar of Sulphur* *Fixed Alkali* *Borax* *Calx of Lead* *Calx of Antimony*	*Phlogiſton* *Vitriolic Acid* *Nitrous Acid* *Marine Acid* *Vegetable Acids* *Zinc* *Iron* *Copper* *Lead* *Tin* *Regulus of Antimony* *Cobalt* *Arſenic* *Biſmuth*	*Phlogiſton* *Vitriolic Acid* *Nitrous Acid* *Marine Acid* *Acetous Acid* *Zinc* *Iron* *Copper* *Biſmuth* *Mercury* *Silver* *Gold*	*Phlogiſton* *Zinc* *Iron* *Copper* *Lead* *Biſmuth*	*Phlogiſton* *Zinc* *Iron* *Copper* *Tin* *Lead* *Biſmuth* *Regulus of Antimony* *Mercury* *Arſenic*	*Phlogiſton* *Zinc* *Iron* *Cobalt* *Copper* *Biſmuth* *Lead* *Mercury* *Regulus of Antimony* *Silver* *Arſenic* *Tin* *partly*	*Phlogiſton* *Zinc* *Iron* *Copper* *Silver* *Tin* *Lead* *Mercury* *Biſmuth* *Regulus of Antimony* *Arſenic*	*Phlogiſton* *Zinc* *Iron* *Cobalt* *Copper* *Tin* *Arſenic* *Biſmuth* *Mercury* *Lead* *Regulus of Antimony* *Gold*	*Phlogiſton* *Zinc* *Iron* *Copper* *Arſenic* *Lead* *Tin* *Regulus of Antimony* *Cobalt* *Biſmuth*	*Iron* *Copper* *Tin* *Lead* *Silver* *Biſmuth* *Regulus of Antimony* *Mercury* *Arſenic* *Cobalt*	*Gold* *Silver* *Iron* *Copper* *Lead* *Tin* *Regulus of Antimony* *Biſmuth* *Zinc* *Cobalt*	*Copper* *Iron* *Tin* *Zinc* *Regulus of Antimony* *Biſmuth* *Lead* *Silver* *Arſenic (partly)*	*Zinc* *Iron* *Copper* *Tin* *Lead* *Silver* *Gold* *Regulus of Antimony*	*Zinc* *Iron* *Copper* *Tin* *Lead* *Silver* *Biſmuth* *Gold*	*Zinc* *Copper* *Tin* *Lead* *Iron* *Silver*	*Iron* *Copper* *Tin* *Lead* *Silver* *Gold*	*Copper* *Iron* *Silver* *Gold* *Tin* *Lead (partly)*	*Silver* *Gold* *Tin* *Copper*	*Iron* *Copper* *Silver* *Gold*	*Gold* *Silver* *Copper*	*Gold* *Silver*	*Gold*	*Gold* *Silver* *Biſmuth* *Zinc* *Tin* *Lead* *Copper* *Regulus of Antimony*	*Calx of Lead* *Calx of Cobalt* *Calx of R. of Antimony* *Calx of Gold* *Calx of Silver* *Calx of Copper* *Calx of Iron* *Calx of Biſmuth* *Calx of Zinc* *Calx of Mercury*
BODIES NOT SOLUBLE BY THE SUBSTANCES PLACED AT THE HEAD OF THE COLUMNS IMMEDIATELY ABOVE THEM.																											
	Siliceous Earth	*Siliceous Earth*	*Siliceous Earth* *Calcareous Earth*	*Siliceous Earth*	*Gold* *Silver*		*Gold* *Silver* *Tin* *Mercury*	*Gold* *Silver (partly by the dry way)*	*Gold*	*Gold*	*Silver*	*Gold* *Silver*	*Gold* *Zinc*			*Biſmuth*		*Biſmuth*	*Zinc*		*Iron*					*Iron* *Cobalt*	

A TABLE OF AFFINITIES BETWEEN SEVERAL SUBSTANCES, BY MR. GEOFFROY.

1. Acid Spirits	2. Marine Acid	3. Nitrous Acid	4. Vitriolic Acid	5. Abſorbent Earth	6. Fixed Alkali	7. Volatile Alkali	8. Metallic Subſtances	9. Sulphur	10. Mercury	11. Lead	12. Copper	13. Silver	14. Iron	Regulus of Antimony	Water
Fixed Alkali *Volatile Alkali* *Abſorbent Earths* *Metallic Subſtances*	*Tin* *Regulus of Antimony* *Copper* *Silver* *Mercury* *Gold*	*Iron* *Copper* *Lead* *Mercury* *Silver*	*Phlogiſton* *Fixed Alkali* *Volatile Alkali* *Abſorbent Earths* *Iron* *Copper* *Silver*	*Vitriolic Acid* *Nitrous Acid* *Marine Acid*	*Vitriolic Acid* *Nitrous Acid* *Marine Acid* *Acetous Acid* *Sulphur*	*Vitriolic Acid* *Nitrous Acid* *Marine Acid*	*Marine Acid* *Vitriolic Acid* *Nitrous Acid* *Acetous Acid*	*Fixed Alkali* *Iron* *Copper* *Lead* *Silver* *Regulus of Antimony* *Mercury* *Gold*	*Gold* *Silver* *Lead* *Copper* *Zinc* *Regulus of Antimony*	*Silver* *Copper*	*Mercury* *Lapis Calaminaris*	*Lead* *Copper*	*Regulus of Antimony* *Silver Copper Lead*	*Iron* *Silver Copper Lead*	*Spirit of Wine* *Neutral Salts*

But this theory does not ſufficiently explain why combuſtible bodies may be kept red-hot in cloſe veſſels, without any conſumption; becauſe then it cannot be doubted but that the matter of fire is, by the movement excited during ignition, continually applied, and even impelled upon the combuſtible body, without its burning or conſuming. It has then all the appearance of a body burning and penetrated by fire, but it is by an extraneous fire that it is ſo penetrated; its own inflammable matter is not conſumed, and reſts unalterable in midſt of a moſt intenſe fire.

However this be, it is very certain that the acceſs of air is indiſpenſibly neceſſary to maintain the combuſtion of bodies. But it is at the ſame time very difficult to find the true cauſe of this fact. The phenomena of combuſtion ſeem to prove, that the air materially concurs to the production of flame, and makes a part of it: for a given quantity of air can maintain only, during a limited and determinate time, the combuſtion of a certain quantity of inflammable matter. If, for example, a lighted wax candle be placed under an inverted glaſs bell, which is joined exactly to its ſupport, the flame of the wax candle ſubſiſts during a certain time, ſo much longer as the bell is larger, but conſtantly diminiſhing till at length it is extinguiſhed; becauſe the quantity of air contained in the bell being a determinate quantity, and not capable of being renewed, cannot ſerve but for a certain quantity of combuſtion. Another phenomenon worthy of obſervation in this experiment is, that after the extinction of the wax candle, a real vacuum is formed under the bell, which is then as ſtrongly preſſed upon its ſupport, as if a vacuum had been made by an air-pump; which proves demonſtrably that the air which it included, materially concurred to the production of flame; ſince, if it were not ſo, the air being greatly rarified by the heat within the bell, would, on the contrary, make an effort to raiſe itſelf, and would eſcape violently as ſoon as it could.

If we reflect but a little on theſe phenomena, many queſtions occur very intereſting, but at the ſame time very difficult of ſolution. In fact, does the air, which diſappears in this experiment, form a new compound with the inflammable principle of the burnt body by a new combination? If it be ſo, what is this compound? and what becomes of it? or is the air itſelf a neceſſary pabulum or food of flame? Is it decompoſed by the act of combuſtion? If ſo, the air is not a ſimple body: what then is the nature of its principles? and what becomes of them?

be procured by diſtillation have no conſiderable action upon metals, and when they are ſuſceptible of riſing with a degree of heat which does not exceed, or but little, the heat of boiling water, copper alembics well tinned in their internal ſurface are employed.

The moſt convenient of theſe alembics, and which may be employed for many kinds of diſtillation, are compoſed of the following pieces. The firſt is a kind of pot deſigned to contain either the matters intended for diſtillation, or water, in which is immerſed another ſmaller veſſel of the ſame form, and made to contain the matters intended for diſtillation by the water-bath. Theſe pieces of the alembic are called in general *cucurbits*; becauſe formerly they were of an oblong form, upright, contracting themſelves in their upper part, and diminiſhing into a kind of neck, which made them reſemble a cucurbit, or gourd, or a *bladder*, by which latter name alſo they have been diſtinguiſhed.

The cucurbits of copper alembics uſed now have no reſemblance to this form: on the contrary, they are broad, not very deep, and wide. This new form of cucurbits is much more advantageous, as by it the diſtillations are much accelerated, with equal heat. The reaſon of this is, that the quickneſs of diſtillation is always proportionable to the quickneſs of evaporation; and that as evaporation is always made at the ſurface of bodies, the more ſurface theſe bodies preſent, the more quick and eaſy will be the evaporation. But the broad and wide form of modern cucurbits is infinitely more proper for the expoſing of much ſurface of the bodies contained, and particularly of liquid bodies, than the form of the ancient cucurbits, which were high and ſtrait.

The firſt of theſe two pieces is of copper, that it may reſiſt the action of the fire: the ſecond is generally of tin, and ought to be ſo ſhaped, that it can enter exactly into the former piece, and that they ſhould fit ſo well as to render any luting unneceſſary.

There ought to be a ſmall pipe or neck at the upper part of the firſt piece, which may be exactly cloſed, and through which water or other fluid may be introduced at pleaſure.

The third piece of the alembic is called the *capital*, becauſe it is a kind of head. This piece has the form of a hollow cone. It is furniſhed with a gutter or channel, which is placed along its inner and lower circumference.

This capital has alſo in its lower part a kind of neck, which ought to enter ſo exactly into either of the two former pieces, as no luting ſhall be neceſſary. Laſtly, it ought to have a pipe, called the *beak*, which opens inwardly into the gutter.

This beak ought to be from fifteen to eighteen inches externally, and ſo inclined, that it ſhall make with the neck of the alembic an angle of about ſixty degrees.

The fourth piece of a copper alembic is called the *refrigeratory*. It is a kind of bucket, ſurrounding the capital, to which it is exactly ſoldered in its lower part. In this, near its bottom, is inſerted a cock. The uſe of the refrigeratory is to contain cold water to facilitate the condenſation of vapors circulating in the capital. Its cock ſerves to empty the water when it is become too hot, that it may be ſupplied with cold.

As in copper alembics the refrigeratory and capital are joined, they may be conſidered as making only one piece. However, it is neceſſary to diſtinguiſh them; firſt, becauſe their uſes are very different; and, ſecondly, becauſe the refrigeratory is not eſſential to the alembic. Several chemiſts, good operators, are doubtful concerning its utility, particularly ſince the cuſtom was introduced of applying worms to alembics.

The *worm* is a long, tin, ſpiral pipe, included in a copper bucket, ſo that its upper and lower extremities ſhall come out of the bucket by two holes, round which they are well ſoldered. The upper extremity of the worm receives the beak of the alembic, and its lower extremity enters into a receiver fitted to it. The bucket containing the worm is filled with cold water, which cools and condenſes the vapors paſſing through it. The principal advantage which this refrigeratory has over that ſurrounding the capital, is, that it is not ſubject to retard or even to ſtop the diſtillation, as this latter one is: for this inconvenience has been obſerved to happen, whenever the capital of the alembic has been expoſed to a certain degree of cold. There is in M. Beaumé's Elements of Pharmacy a very exact deſcription, and a good engraving of a copper alembic with its worm.

The alembics deſcribed are of great uſe for the diſtillation of the *ſpiritus rector* of vegetables, of their *diſtilled waters*, of their *eſſential oils*, of pure *ardent ſpirits*, of ſpirits charged with the odoriferous principles of plants, and alſo for many other diſtillations of this kind. But as it is frequently neceſſary to diſtill in alembics acid and ſaline liquors capable of attacking metals, glaſs alembics are employed for ſuch diſtillations: and theſe are generally compoſed of only two

pieces,

pieces, namely, a cucurbit, and a capital, which is fitted above and joined by luting. There are glaſs cucurbits, high and ſtrait, which may be uſeful for the diſtillation of certain very volatile ſubſtances. Others are made ſhallow and broad, and theſe have the ſame advantages from their form as the metal ones have.

To avoid the luting of the capital with the cucurbit, theſe glaſs alembics have been made of one entire piece. The capital of theſe alembics, which are of cryſtal glaſs, ought to have an opening at its top, which may be exactly cloſed with a cryſtal ſtopper ground with emery. This opening is intended for the introduction of matters to be diſtilled, and for the extraction of the reſiduums after diſtillation. Theſe alembics of one piece, although ſometimes convenient, are ſeldom employed on account of their dearneſs, and of the difficulty of introducing, and of extracting ſolid matters.

There are alſo made cucurbits of ſtone-ware, and of glazed earthen ware, which are uſeful in many caſes. *See at the word* DISTILLATION *ſeveral obſervations relative to the form and matter of alembic* *See Plate* I.

ALKAHEST. This is a name given by ancient chemiſts to a pretended univerſal menſtruum. Such a menſtruum either does not exiſt, or elſe there is not any body in nature which may not become an alkaheſt. For although certain ſubſtances have not hitherto been combined with others, the daily diſcoveries in chemiſtry of combinations formerly believed impoſſible, ſeem to prove, that by certain management, and certain circumſtances, any ſubſtance may be combined with all others; or, in other words, that all bodies may be diſſolved by any ſingle ſubſtance (*b*).

ALKALESCENT. This word is employed to denote a matter ſlightly alkaline, or which begins to turn to the alkaline and putrid fermentation.

ALKALI (FIXED). Fixed alkali is a ſubſtance compoſed of acid, of earth, and of a little phlogiſton; and whoſe principles have to each other a weaker adheſion, than the principles of any acid have to each other. There are ſeveral kinds of ſaline alkaline ſubſtances. Theſe are vegetable alkali, mineral or foſſile alkali, and volatile alkali. They are all called by the general name *Alkali*, becauſe the following properties are common to them all.

(*b*) Kunckel very well ſhews the abſurdity of ſearching for an univerſal ſolvent by aſking, "If it diſſolves all ſubſtances, in what veſſel can it be contained?"

1. Alkalies may eaſily be obtained dry and concrete, and freed from all water unneceſſary to their ſaline eſſence (*c*). When they are in this ſtate,

2. They produce heat by adding water to them.

3. They attract the moiſture of the air, and deliquiate into a liquor (*d*).

4. They change the color of ſyrup of violets into green, whether they be dry or fluid (*e*).

5. They have an acrid, burning taſte, ſo much ſtronger as they are purer and dryer. This taſte has ſomething *urinous*; and hence they are called by ſome chemiſts *urinous ſalts*. They are alſo called *lixivial ſalts*, becauſe the method of obtaining fixed alkalies conſiſts in lixiviating the aſhes of certain vegetable ſubſtances.

6. They partly exhale with water, particularly when boiled in open air.

7. When they are dryed and re-diſſolved, ſome earth is always ſeparated from them.

8. They may be fuſed by a moderate heat.

9. When fuſed, they diſſolve all earths.

10. When added to earths, and particularly to thoſe called vitrifiable earths, and expoſed to a ſufficient degree of heat, they and the earths become glaſs. *See* VITRIFICATION.

11. When added in a large proportion to the earths with which they are fuſed or vitrified, they communicate to theſe earths all their own properties. *See* LIQUOR *of* FLINTS.

12. They effervеſce and unite with acids to the point of ſaturation more perfectly and more intimately than pure abſorbent earths, and from this union reſult different neutral ſalts.

13. They decompoſe all ſalts with baſes of earths, metals, or volatile alkali. They ſeparate theſe baſes, and unite with the acids of the ſalts, with which they form new neutral ſalts. This is an example of ſtronger affinity, from whence reſult a new decompoſition and a new combination.

(*c*) Volatile alkali retains water ſo ſtrongly, that it cannot be obtained dry, unleſs by combining it with fixable air, and then it becomes cryſtallizable. The fixed alkalies may be rendered dry by application of heat, but are only cryſtallizable by help of fixable air. *See* GAS

(*d*) Mineral alkali does not deliquiate by expoſure to air; but on the contrary, when cryſtallized, it is apt to become dry, and to loſe the water which is neceſſary to its cryſtalline ſtate.

(*e*) Concerning the effects of acids and alkalies on the color of ſyrup of violets, *ſee the note (d) ſubjoined to the article,* ACID.

Alkaline ſalts being ſubſtances pretty ſimple, as well as acids, are powerful ſolvents. They are capable of combining not only with all acids and with all earths, as we have ſaid, but alſo with ſulphur and with oily matters. With ſulphur they form a ſulphureous ſoap, ſoluble in water, called *liver of ſulphur*; which *ſee*.

With oils, fat, reſins, &c. they form compounds, which have been called *ſoaps*. In each of theſe combinations, the alkali is a medium by which the inflammable ſubſtance, naturally unſoluble, and even immiſcible in water, becomes miſcible and ſoluble in that liquid. *See* SOAP.

Theſe ſaline ſubſtances can act alſo upon ſpirit of wine, when they are deprived of all the water unneceſſary to their eſſence as ſalts. Alkalies, in that ſtate, applied to ſpirit of wine, firſt deprive it of its ſuperfluous water; afterwards, when in a proper proportion, they act upon its own ſubſtance, by combining with it, and cauſing ſeveral alterations, and even a decompoſition of its parts. *See* SPIRIT *of* WINE (TARTARISED), *and* TINCTURE *of* SALT *of* TARTAR.

Laſtly, alkalies act upon metallic ſubſtances with more or leſs facility, according to their natures, and the different means employed; which ſhall be mentioned under the ſeveral articles of the alkalies and metals.

N. B. All that has been ſaid above concerning alkalies, may be applied to all the ſeveral kinds of alkalies, even to thoſe called *volatile*, excepting thoſe properties which depend upon fixity. Hence this article is applicable to alkalies in general. But it is neceſſary to obſerve, that a very juſt idea cannot be formed of theſe generalities, without entering into the details of what concerns the ſeveral kinds. *See for the affinities of fixed alkali, and for its medicinal virtues, the word* ALKALI (FIXED MINERAL).

ALKALI (FIXED VEGETABLE). This name is given to all fixed alkalies obtained by burning any vegetable ſubſtances, and which have not the properties of the alkali, which is the baſis of common ſalt, which has been called the alkali of common ſalt, the *marine alkali*, *mineral* or *foſſil alkali*.

The common method of obtaining fixed alkalies from vegetable ſubſtances, conſiſts in burning theſe ſubſtances freely and in open air, till they be reduced to aſhes. *See* COMBUSTION *of* PLANTS. After which theſe aſhes are lixiviated with very pure water, till the water comes from them inſipid. This lixivium is evaporated to dryneſs; and what remains is the fixed alkaline ſalt of the plant, which may be deprived of its ſuperfluous water and ſuperfluous phlogiſton by calcination with a long and gentle fire.

Fixed alkalies obtained from any vegetable matters when well prepared and carefully purified by means hereafter to be deſcribed, are all exactly alike, and have the ſame properties; ſo that they are only one and the ſame kind of ſaline ſubſtance. But as it is very difficult to procure this ſalt in its utmoſt degree of purity, and as, in this reſpect, there is a difference betwixt thoſe obtained from different vegetable matters, ſome of them being naturally purer or more eaſily ſuſceptible of purification than others; and further, as ſufficient attention has not been given to the means of perfectly purifying theſe alkalies, two inconveniences have happened. The firſt is, that ſeveral chemiſts have imagined that there was an eſſential difference betwixt alkalies obtained from different plants: and the ſecond is, that other chemiſts have attributed to alkalies in general, ſeveral properties not belonging to them as alkalies, but to certain foreign ſubſtances adhering to them. We here conſider the vegetable alkali perfectly purified: and after we have enumerated its principal properties, we will treat of its origin, of its formation, and of the means of purifying it.

Fixed vegetable alkali has all the properties related under the article ALKALI (FIXED).

It is ſolid or concrete, like an earthy ſubſtance; of a fine white color; without tranſparency, or cryſtalline and regular ſhape, becauſe, in fact, it is not ſuſceptible of cryſtallization *(f)*; of no ſmell while it is dry, but of a ſlight lixivial ſmell when moiſtened with water. It has a violent, ſharp, burning, cauſtic and urinous taſte; that is to ſay, that when put in the mouth, it diſcovers a taſte of putrified urine, which is cauſed by the diſengagement of volatile alkali from animal ſubſtances.

Here it is proper to obſerve, that when it is required to taſte fixed alkali, it is convenient to diſſolve and dilute it in much water, which only leſſens its ſtrength without altering its character: otherwiſe the tongue might be bliſtered, be-

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(f) Fixed vegetable alkali does not ſo readily cryſtallize as mineral alkali does. It is nevertheleſs cryſtallizable by expoſing it to the permanently elaſtic fluids produced by the efferveſcence of alkaline ſubſtances with acids, by the combuſtion of vegetable and animal ſubſtances, and by other methods. *See* GAS.

cauſe calcined alkali is powerfully cauſtic, and quickly corrodes and deſtroys all animal matters *(g)*.

Fixed alkali, expoſed to air, attracts moiſture, with which it reſolves, or deliquiates into a white tranſparent colorleſs liquor like pure water. Fixed alkali attracts thrice its quantity of moiſture, according to Gellert. *Chemie Metallurgique*, *Tom.* 1. *p.* 26.

The ſame thing happens if it be purpoſely diſſolved in water. But in this latter caſe, at the firſt inſtant of the mixture, a pretty ſtrong heat is excited by the activity of the union of alkali and water. This heat, however, is much leſs than what ariſes from the mixture of concentrated vitriolic acid and water.

Every time that fixed alkali is diſſolved in water, a portion of indiſſoluble matter remains. If the ſolution be filtered, it paſſes very clear: but after ſome time, it begins to be turbid, and ſmall flocks are formed in it of a matter which falls to the bottom of the veſſel, and cannot afterwards be rediſſolved. This matter is of the ſame nature as the firſt ſubſtance which we obſerved remains undiſſolved; and is nothing elſe than a portion of the earth of the alkali, which is ſeparated every time that the ſalt is calcined and diſſolved. The part which at firſt paſſes through the filter, and which afterwards renders the liquor turbid, is that part which was the moſt attenuated, and moſt adhering to the alkaline ſalt. This earth thus ſeparated, is no longer in a ſaline ſtate, and conſequently becomes indiſſoluble in water like pure earths.

Alkali diſſolved in the ſmalleſt poſſible quantity of water, forms a liquor leſs fluid, more thick and unctuous than pure water, and which paſſes with more difficulty through the filter, from the quantity of ſaline matter with which the water is charged. When it is touched and rubbed betwixt the fingers, it appears to have a fat and oily nature; which proceeds from the greaſy particles of the ſkin diſſolved by it. Theſe properties have occaſioned it to be called, but improperly, an *oil*, by ancient chemiſts. *See* OIL *of* TARTAR. It ought to be called the *Liquor of alkaline Salt*.

Dry fixed alkali, expoſed to a moderate fire, that is, a little more than cherry red, ſuſtains its action pretty well, altho' it fuſes, and diminiſhes in quantity. But by a very violent

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(g) The cauſe of this is, that by calcination fixed alkali is deprived of a part of its gas, and is thereby rendered more ſoluble, and conſequently more cauſtic. *See* GAS.

violent fire, the greateſt part of it is diſſipated in vapors, or even all of it, if the heat be ſufficiently long and intenſe. It is eaſy to be convinced of this, by obſerving the pots in which glaſs is melted in glaſs-houſes. Above theſe pots a perpetual ſmoke may be ſeen, which can proceed only from the fixed alkali which enters into the compoſition of glaſs; the other matters which enter into that compoſition being infinitely more fixed than it.

Fixed alkali is a very powerful ſolvent. In the dry way, and by help of proper heat, it diſſolves all calcareous, vitrifiable, argillaceous, gypſeous, and metallic earths; and in certain proportions, and nearly in equal parts, it changes moſt of theſe into different kinds of hard, ſolid, and tranſparent glaſſes. *See* GLASS, VITRIFICATION, CRYSTAL-GLASS.

When a third or fourth part only of earth is added to alkali, they more readily fuſe, and unite together: and as the alkali is the prevailing principle in the new compound which reſults from this union, ſo its properties alſo prevail. Hence it renders the earths ſo diſſolved, ſoluble in water, and in acids, and ſuſceptible of attracting the moiſture of the air, &c. *See* LIQUOR *of* FLINTS.

The alkali appears to have no action by the humid way upon ſubſtances purely earthy; but it has upon quicklime, to which it gives, and from which it receives, very ſingular alterations. When it is liquid, and treated with this ſubſtance, it becomes infinitely more cauſtic and more fuſible than it was before. *See* LIXIVIUM *of* SOAP-BOILERS, CAUTERY (*h*).

Fixed vegetable alkali unites with the vitriolic acid violently and with great effervеſcence. The union of theſe two ſaline ſubſtances is very ſtrong and very intimate; and from thence reſults a perfect neutral ſalt, which is *vitriolated tartar*. *See* TARTAR (VITRIOLATED).

With nitrous acid it forms *nitre*, a neutral cryſtallizable ſalt, the properties of which ſee under the word NITRE.

With marine acid, fixed vegetable alkali forms a particular kind of common ſalt, reſembling in many reſpects the native common ſalt, but differing from it in others, and chiefly in its taſte, which is much leſs agreeable than that of

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(*h*) The cauſticity which alkaline ſalts acquire by being treated with quicklime, is occaſioned by this ſubſtance depriving them of their gas, to which it has a ſtronger power of combination than they have. *See* GAS.

common ſalt. The differences betwixt theſe two ſalts are cauſed by the difference of their alkaline baſes, native common ſalt having for its baſis a particular kind of fixed alkaline ſalt, which differs conſiderably from the fixed vegetable alkali. The kind of common ſalt formed with this latter alkali and marine acid is called *regenerated common ſalt*, or SALT (FEBRIFUGAL) *of* SYLVIUS. *See that article.*

Fixed vegetable alkali unites alſo very well with vegetable acids, and with them forms different neutral ſalts, according to the nature of theſe acids. With the acid of vinegar, it makes a neutral deliqueſcent ſalt, of a very pungent taſte, called, *regenerated tartar*, or *Terra foliata tartari*; ſee theſe words. With the concrete vegetable acid, or cream of tartar, it forms a neutral cryſtallizable ſalt called *tartariſed tartar*, or *Salt* (*vegetable*); which ſee.

Laſtly, fixed vegetable alkali unites alſo and forms true neutral ſalts with any ſubſtances, which, though not pure acids, do however act as acids with relation to alkalies. Such is the ſedative ſalt, with which this alkali forms a particular kind of *Borax*. *See* BORAX *and* SALT (SEDATIVE). Such alſo is arſenic, with which it unites to the point of ſaturation, and forms a very ſingular, neutral, cryſtallizable ſalt, the properties of which were firſt obſerved by M. Macquer, who gave it the name of *neutral arſenical ſalt*. *See* SALT (NEUTRAL ARSENICAL).

Fixed vegetable alkali diſſolves ſulphur in all its ſubſtance; that is, it unites with both the acid and the phlogiſton of which this mineral matter is compoſed. It only diminiſhes the adheſion of theſe two conſtituent parts of ſulphur. This union of alkali with ſulphur may be made in the humid way and in the dry way; but much better in the latter. Hence reſults a particular ſaponaceous body, called *liver of ſulphur*, which is a powerful ſolvent of all metallic ſubſtances. *See* LIVER *of* SULPHUR.

Metallic ſubſtances are capable of being attacked and diſſolved by pure alkali. Some of them, ſuch as iron, and particularly copper, need only to be digeſted in the liquor of alkaline ſalt, to be perfectly diſſolved. Moſt of the others require to be previouſly diſſolved by acids: but by means of this ſolution in acids they become very ſoluble in alkali. For this purpoſe it is neceſſary to pour ſome drops of metallic ſolution into a very ſtrong liquor of alkaline ſalt: at firſt a precipitate is formed, which diſappears when the liquor is agitated; thus the acid metallic ſolution is to be continued to be poured in at different times into the alkaline liquor, till this latter cannot any longer diſſolve the precipitate.

All metals are not by this method diſſolved with equal facility, and in equal quantities by fixed alkali. The lunar metals, namely, ſilver, mercury, and lead, are diſſolved by it with more difficulty and in leſs quantity than the ſolar metals, ſuch as gold, platina, tin, copper, and eſpecially iron. This laſt metal gives to the alkali while it is diſſolving a beautiful ſaffron color, approaching to red. This ſolution of iron by alkali was firſt publiſhed by Stahl, and by him called *martial alkaline tincture*. *See* TINCTURE (MARTIAL ALKALINE) *of* STAHL.

It is proper to obſerve upon the ſubject of the ſolubility of metals in fixed alkali; 1. That in order to its ſucceſs, it is very neceſſary that the previous ſolution of metal in an acid ſhould be very acid, and very far from the point of ſaturation. In whatever manner the operation is done, it always fails in making the martial alkaline tincture of Stahl, if a very ſaturated ſolution of iron in nitrous acid be employed. M. Macquer and Mr. Beaumé have aſcertained the neceſſity of this management, which is not obſerved by Stahl or any other chemiſt.

2. Moſt of theſe metallic ſolutions in alkali preſerve their limpidity only during a certain time; after which they become turbid, and a depoſition is then formed, of the ſame color as the ſolution. This depoſition is nothing elſe than a portion of the diſſolved metal which ſeparates from the ſolvent, as happens to ſeveral ſolutions of metals in acids.

3. A very illuſtrious chemiſt recommends for the ſolution of metals in fixed alkali, particularly of gold, ſilver, mercury, zinc, biſmuth, an alkali phlogiſticated and fit to make Pruſſian blue. But this is the preciſe way to fail in the operation. This able chemiſt has been led into error by ſome of thoſe circumſtances, which are but too frequent in chemiſtry, and againſt which it is impoſſible for the moſt intelligent perſons to be always guarded. Some details upon this ſubject may be ſeen under the articles BLUE (PRUSSIAN), *and* TINCTURE (MARTIAL ALKALINE) *of* STAHL.

By fuſion and by the dry way, fixed alkali diſſolves and vitrifies all metallic calxes, or earths deprived of phlogiſton; perhaps even it is capable of diſſolving the metals uncalcined.

Fixed vegetable alkali unites eaſily with oils and oily ſubſtances, and communicates to them its property of mixing well with water. With them it forms ſaponaceous compounds,

pounds, partaking of the properties of oil, and of thoſe of alkaline ſalt, as has been ſaid under the article of alkali in general. *See the word* SOAP.

As to the origin of fixed vegetable alkali, it is diſputed whether it exiſts ready formed in vegetables previouſly to their combuſtion, by which it is obtained, but which in this ſuppoſition does only diſengage ſubſtances which envelope and diſguiſe it; or whether vegetables contain only the materials proper for its formation, which conſequently takes place in the act of burning, and whether it be, properly ſpeaking, produced by fire.

There are reaſons for and againſt theſe two opinions; and they are ſo ſtrong on both ſides, that there are grounds to believe that both of them are true; that is to ſay, that the fixed alkali obtained after burning a vegetable, did partly exiſt ready formed in that vegetable before it was burnt, and that the other part was produced by the very act of combuſtion.

The proof of the former part of this propoſition is, that from moſt plants neutral ſalts whoſe baſes are fixed vegetable alkali, ſuch as vitriolated tartar and nitre, may be actually obtained without burning. And alſo, M. Beaumé, upon a particular examination of the plant called *corona ſolis*, found that this plant, when well cultivated, furniſhed not only a very conſiderable quantity of perfect nitre, very ſuſceptible of cryſtallization and detonation, the baſe of which conſequently was fixed vegetable alkali, but alſo a large quantity of this alkali, diſengaged from any acid, and poſſeſſed of all its properties. An alkali then does exiſt in vegetables previous to burning. It remains to be examined whether this alkali exiſting in plants previous to burning, be truly one of their principles and conſtituent parts, or only a foreign and unneceſſary ſubſtance. What renders the latter opinion probable, is, that the quantity of alkali in plants, whether diſengaged or united to an acid in neutral ſalts, is very variable, and that it appears to depend ſolely on culture and on the nature of the ſoil: ſo that it frequently happens, that the ſame plants which contain much alkali when theſe two circumſtances favor its introduction, contain none at all in contrary circumſtances.

As to the ſecond propoſition concerning the origin of fixed vegetable alkali, which is, that a great part of this alkali is produced and combined by the act of combuſtion, it is eſtabliſhed by ſeveral proofs ſeemingly inconteſtable. The obſervation of the circumſtances concurring to the production of alkali by burning, demonſtrates that this alkali is in great meaſure formed by the vegetable acid, which, during the deflagration of vegetables, combines in a particular manner with a portion of their earth and inflammable principle.

The following obſervations will render this truth evident:

1. When vegetables capable of furniſhing aſhes containing much alkali, are decompoſed by other means than combuſtion, ſcarcely any other ſaline matters are obtained from them but fluor acids, or elſe what are properly called eſſential ſalts, which are nothing more than concrete acids rendered ſolid by a portion of oil and earth.

2. When vegetables are deprived of a part of their acid by diſtillation, or by extraction of their eſſential ſalts, the quantity of fixed alkali obtained from their aſhes is leſs than it otherwiſe would have been in proportion to the quantity of acid previouſly taken away.

3. The matter of extracts containing almoſt all the acid of the vegetables uſed for that extraction, and the eſſential ſalts of vegetables are, of all vegetable matters, thoſe which furniſh the greateſt quantity of fixed alkali by burning in open air. The concrete acids particularly are changed by this proceſs almoſt entirely into fixed alkali. A ſtriking example of this is ſeen in the combuſtion of tartar, which is one of thoſe concrete acids.

4. Oils and oily concretions, which contain little acid and earth, leave after burning a ſcarcely ſenſible quantity of fixed alkali.

5. Plants which contain a very volatile acid, and thoſe from which no acid is obtained by diſtillation, ſuch as muſtard-ſeed, leave alſo in their aſhes but an almoſt inſenſible quantity of fixed alkali.

6. All vegetables, even thoſe which in their natural ſtate furniſh aſhes containing much fixed alkali, when burnt, after their acid has been altered by a complete putrefaction, leave aſhes entirely free from alkali.

We cannot therefore but conclude, after having attended to theſe facts, that the greateſt part of the fixed vegetable alkali is produced from the acids of vegetables.

We ought alſo, after what has been ſaid on the origin and production of fixed alkali, to perceive the reaſon, why vegetable matters, which have undergone decoctions, or long macerations in much water, as floated wood, leave but little or no alkali in their aſhes. The water has diſſolved and carried off either the alkali ready formed, or their acids and eſſential ſalts, which, as we have ſeen, are the principal materials of its compoſition.

Fixed alkali prepared by the incineration of vegetable ſubſtances, and by lixiviating and evaporating to dryneſs, is very far from the degree of purity requiſite in exact chemical experiments.

It is almoſt always altered; 1. By ſome remaining inflammable principle, which could not be entirely conſumed during the burning; 2. By a portion of ſuperabundant earth; 3. By the mixture of different ſaline matters as fixed as itſelf, which partly or entirely elude the action of the fire. Theſe ſaline matters are either ſome neutral ſalts, which are frequently found in plants; ſuch as vitriolated tartar, Glauber's ſalt, common ſalt, and ſometimes a little nitre; or a portion of fixed mineral alkali. 4. As iron is diffuſed in almoſt all bodies, and particularly in greater or leſs quantity in the aſhes of vegetables, as Mr. Geoffroy has proved; and further, as iron is very ſoluble by fixed alkali; this ſaline ſubſtance is ſubject to be altered by mixture with iron.

Fixed alkali may be diſcovered to be phlogiſticated, or altered by a ſuperabundance of inflammable matter; 1. By its color not being perfectly white, and by its lixivium or ſolution in water being more or leſs yellow, or red inſtead of being abſolutely colorleſs; 2. By the ſmell of its lixivium, which is always ſo much ſtronger, as it is more phlogiſticated; 3. By its degree of cauſticity, which is always ſo much leſs as it retains more ſuperabundant inflammable matter; 4. Laſtly, by its property of forming Pruſſian blue, by precipitating ſolutions of iron in acids, when it is much phlogiſticated. *See upon this laſt article*, BLUE (PRUSSIAN).

There are two methods of purifying fixed alkali thus altered, that is, of depriving it of all the ſuperabundant inflammable matter it contains. The firſt is by calcination, according to the general rules and with all the attentions neceſſary to be obſerved in calcining by fire. *See* CALCINATION.

The ſecond method of purifying fixed alkali from ſuperabundant inflammable matter conſiſts in applying to it a body on which it cannot act, and which has a ſtronger affinity than it with this inflammable matter. M. Beaumé firſt practiſed this ſecond method. This able obſerver, having perceived, that when he evaporated in ſilver veſſels red and phlogiſticated alkaline lixiviums, theſe veſſels were more and more tarniſhed, till at length the ſurface of the ſilver became quite black, and that the lixivium loſt its color in proportion as the ſilver acquired it, carried this experiment as far as poſſible; and at length, by renewing the ſurface of the ſilver contiguous to the alkaline lixivium, he deprived this lixivium of all its color, and rendered it entirely white. This lixivium being then evaporated to dryneſs, furniſhed an alkali very white, very cauſtic, and free from all ſuperabundant phlogiſton. Beſides the practical method of dephlogiſticating alkaline ſalt, which this experiment ſuggeſts, it alſo confirms a truth demonſtrated by M. Macquer in his theory of Pruſſian blue; namely, that metallic ſubſtances may be charged with a ſuperabundant quantity of inflammable matter, and that they are capable of taking it from fixed alkali by the humid way. *See* Blue (Prussian).

The ſecond ſubſtance which alters fixed alkali is a ſuperabundant earth. As this earthy ſubſtance is not ſoluble in water when alone, and as it has but a weak adheſion to the alkali, it may be eaſily ſeparated by drying it once or twice, by ſolutions and filtrations. But this purification muſt not be carried too far, becauſe the alkali itſelf is capable of decompoſition by this method, for at every drying or calcination, a part of its earthy principle is diſengaged.

As to the ſaline matters which by their mixture alter the purity of the fixed alkali, they can be ſeparated by no chemical proceſs but by cryſtallization. This method is founded on the incapacity of the alkaline ſalt to cryſtallize, and on its property of decompoſing and of converting into cryſtallizable ſalts all uncryſtallizable and deliqueſcent ſalts with which it may be mixed. It is then neceſſary to evaporate, as much as is convenient, the alkaline liquor from which theſe foreign ſalts are to be ſeparated, and to let it cool at ſeveral different times to favor the cryſtallization of thoſe ſalts which are beſt cryſtallized in the cold, or to continue the evaporation for thoſe ſalts which, like common ſalt, can only be cryſtallized by this method. *See* Crystallization. But it is manifeſt, that this method, however carefully performed, is incapable of procuring a perfect ſeparation of all the extraneous ſalts from the alkali; for, while the alkali continues fluid, it always remains mixed with a ſmall quantity of cryſtallizable ſalts, which are diſſolved by part of the ſame water which keeps the alkali fluid; and therefore the ſeparation by cryſtallization cannot take place when all is evaporated to dryneſs. It is impoſſible to ſeparate completely from the alkaline ſalt, the laſt ſmall portions of extraneous ſalts with which it was mixed. Notwithſtanding this, the degree of purity to which the alkaline ſalt may be brought by this method is conſiderable, and ſufficient for moſt of the operations of the arts, and even for many operations in chemiſtry.

It is ſtill more difficult to purify the alkali from iron. No practical method is known for this purpoſe. When therefore a very pure alkali is required, it is proper to chooſe ſuch ſubſtances as furniſh a ſalt the leaſt impure. For in this reſpect there is a great difference betwixt the ſubſtances from which it may be obtained, as will appear when we enumerate ſummarily the ſeveral alkalies moſt frequently uſed.

Fixed alkali being of great uſe, and much employed in arts, as it is the baſis of ſoap and leys, and much uſed in dying, making of glaſs and ſaltpetre, is procured from matters which furniſh a great deal of it, and at a ſmall expence.

The moſt common alkali, and at the ſame time the leaſt pure, is that of the aſhes of common hearths. Theſe aſhes are employed for lixiviums, in the manufacture of ſaltpetre, and in glaſs-houſes where common bottle-glaſs is made.

In the Northern countries, where wood is plentiful, it is burnt on purpoſe, as well as many plants, to procure from their aſhes a ſtrong but very impure alkali, called *Pot-aſh*. This alkali is always much phlogiſticated, and contains many of the ſaline matters above-mentioned. Pot-aſh is employed for the purpoſes related. It is alſo uſed by dyers in ſome of their operations. Pot-aſh may be purified ſo far as to become a very good alkali by the methods mentioned. (*c*)

(*c*) In ſome parts of Germany Pot-aſh is prepared from the ſame wood of which charcoal is made. A number of tubes, made of plate iron, or of copper or braſs, are ſo diſpoſed in the pile of wood intended to be burnt into charcoal, that the water, acid, and oil, which are obtained in the ordinary method of diſtilling wood, ſhall, when ſeparated from the wood by fire, paſs through theſe tubes into buckets placed to receive theſe liquors. The oil is then to be ſeparated from the acid liquor, which is afterwards to be boiled in copper or iron veſſels, and the reſiduum dried and calcined. By this calcination, the acid ſalt is alkalized. This proceſs, and the preparation of ſalt of tartar by calcining tartar, ſhew that vegetable alkali is produced by converſion of an acid to an alkali. How is this converſion effected?

The dregs and leys of wine being dried and burnt, leave aſhes abounding in alkaline ſalt, called in French, *cendre gravelée*.

The moſt common method of making pot-aſh, is by burning large piles of wood, lixiviating the aſhes by boiling in copper veſſels, decanting the lixivium when clear, and boiling it in other copper veſſels till the liquor be evaporated and a reddiſh ſolid ſalt obtained, called *black pot-aſh*, which by calcination in ovens with a heat not intenſe enough to fuſe it, is dephlogiſticated and rendered white. If any of it has been fuſed, it will have a greeniſh blue color.

Another method of preparing pot-aſh, and which may be conveniently uſed in a large manufactory of it, is deſcribed by Kunckel. The aſhes of wood are put into a large tub, near the bottom of which is inſerted a cock; and to prevent the aſhes from filling up the cock, the bottom is covered with ſtraw and pieces of ſmall wood. Water is to be poured on the aſhes, and is the next day to be let off through the cock into another veſſel. The aſhes may again be elixated with more water till all the ſalt be diſſolved. The weaker leys are to be poured on freſh parcels of aſhes till they can receive no more ſalt. The ley is then to be evaporated in an iron pan, and the brown ſalt is to be dephlogiſticated by calcination in a furnace or oven with a heat not intenſe enough to fuſe it.----Some perſons ſoak ſtraw in the ley obtained by lixiviating wood-aſhes with water, and by drying and burning this ſtraw they obtain a ſalt without the trouble of boiling the ley. The Ruſſia pot-aſh is dark-colored, hard, not eaſily deliqueſcible, and contains (as Dr. Lewis ſays) more than half its weight of an earth unſoluble in water. Scheffer, in the Swediſh Memoirs for the Year 1759, ſays, that from 100lb. of Ruſſian pot-aſh he obtained 92½ lb. of alkaline ſalt, and 7½lb. of neutral ſalts. Dr. Home found that Ruſſian pot-aſh contained a conſiderable quantity of quicklime. From experiments made by Brandt (*Memoires Suedoiſes* 1749), and from the preference given to it by ſoap-boilers, it appears to be more cauſtic, and more powerfully to diſſolve oils, than purer pot-aſh rendered cauſtic by quicklime. Ruſſian pot-aſh is ſaid to be prepared by burning wood with a cloſe ſmothering heat; making a ley from the coarſer part of the aſhes, and moiſtening therewith the finer part into the conſiſtence of a paſte, ſtratifying this paſte with ſome of the more inflammable kinds of wood, and ſetting the pile on fire. The neutral ſalts found in pot-aſh are chiefly vitriolated tartar, ſea-ſalt, with which latter ſalt pot-aſh is frequently adulterated to increaſe its weight.

The aſhes of firs, pines, and all trees which contain much reſin and eſſential oil, yield a ſmall quantity only of fixed alkali by elixation. The cauſe of this ſeems to be, that the acid of theſe *gravelée.* This alkali is not only in great quantity in theſe aſhes, but likewiſe when the matters furniſhing it are properly and carefully burnt, it is the pureſt of all thoſe which are in commerce. If it contains iron, the quantity of this metal is ſcarcely ſenſible; and it is naturally free from mixture of extraneous ſalts: therefore dyers and other manufacturers, whoſe operations require a pure alkali, prefer theſe to any other alkaline aſhes.

Fixed Alkali *of* Tartar.

TARTAR, which is nothing but the concrete acid or eſſential ſalt of wine, being properly burnt, is almoſt entirely changed into an alkaline ſalt, very ſtrong, and the pureſt of all; and which therefore has been reaſonably preferred by chemiſts to any other. It is called the *Alkaline Salt of Tartar*, or ſimply *Salt of Tartar.* Hence this name has become in ſome meaſure ſynonimous with that of alkali.

Salt of tartar is made by wrapping up in wet brown paper the tartar intended to be burnt, and placing theſe parcels ſo wrapped up in a furnace, in beds or ſtrata, together with ſtrata of charcoal, alternately; and by ſetting fire to the whole, and continuing the fire till no more blackening ſmoak ariſes.

As tartar is almoſt entirely changed into alkaline ſalt, it preſerves after incineration a certain conſiſtence, and retains the form it had before burning; which makes it eaſy to collect it properly. But too great heat muſt be prevented in burning tartar, otherwiſe the alkali would melt and flow to the bottom of the furnace, where it would mix with the impurities of the charcoal. To avoid this inconvenience a furnace entirely open may be employed, in which the charcoal may burn freely, but without any ſtrong current of air to render the heat too intenſe. On the other ſide, as fire is generally more intenſe in great than in ſmall operations, where proportionable quantities of combuſtible matters are uſed, when much tartar is to be burnt, it is proper to diminiſh the quantity of charcoal, to prevent too great heat, and the conſequent fuſion of the alkali.

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trees is very volatile, and together with a volatile inflammable matter forms the eſſential oils and reſins. *See* Resins. Plants that are auſtere, acid, bitter, or aromatic, yield by incineration the largeſt quantity of alkali. Rotten, dry, and old plants, burn with little flame, and yield little alkali.

When tartar is ſufficiently burnt, a lixivium muſt be made from it till the water poured on it receives no more taſte. It muſt then be filtered, evaporated, dried and calcined, according to the directions given to obtain the alkali of tartar in its greateſt purity.

Fixed Alkali *of* Nitre.

THE baſis of nitre being a fixed alkaline ſalt of the nature of the vegetable alkali, and the acid of this ſalt being capable of decompoſition and total deſtruction by deflagration, we may obtain ſeparately its alkali, called *alkaliſed or fixed nitre*, by burning or detonating it with combuſtible matters. As this combuſtion is very rapid, and as it is alkaliſed almoſt inſtantaneouſly by detonation, it has been alſo called extemporaneous alkali.

The matters moſt convenient and moſt frequently uſed for the deflagration of nitre are charcoal and tartar. The alkali made by deflagration of nitre with charcoal is called NITRE *fixed by* CHARCOAL. *See this article for the method requiſite.*

Nitre and tartar burnt together produce a very ſtrong alkali, which is a mixture of the alkali of nitre and of the alkali of tartar, both which are entirely of the ſame nature. They are confounded together by the name NITRE *fixed by* TARTAR. *See that article, and* FLUX (WHITE).

Theſe alkalies of nitre, when well prepared, are very pure, and fit for the niceſt operations in chemiſtry.

All theſe ſeveral kinds of alkali, when perfectly purified, have entirely the ſame properties, and ought to be regarded only as one and the ſame alkali, which ought to be called *Fixed Vegetable Alkali.* The purification above-mentioned of this alkali is attended with conſiderable difficulties in practice. The chief of theſe difficulties is in the evaporation and drying of the alkaline lixiviums; and this relates to the veſſels employed in theſe operations. Veſſels made with the imperfect metals are unfit, becauſe they are liable to the action of the alkaline ſalt. Silver veſſels are the fitteſt of all for this purpoſe; but it is not very certain that this metal is incapable of being acted upon by alkali.

Glazed earthen veſſels, ſuch as common pottery-ware, cannot be employed, becauſe they are not, and cannot be ſufficiently baked. The alkaline lixivium paſſes through them as eaſily as through a filter. If veſſels not metallic are to be uſed, they ought to be of glaſs or porcelaine, or made

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of pure clay, and baked in a violent fire, ſuch as that kind of pottery called ſtone-ware. Theſe veſſels perfectly reſiſt the action of alkalies, but they are very liable to be cracked by heat.

Well-prepared fixed alkali ought to be preſerved, either dry or fluid, in cryſtal-glaſs bottles, with glaſs ſtoppers. When the fluid alkali is uſed, it muſt be gently decanted from the ſediment depoſited at the bottom of the bottles.

ALKALI (MINERAL *or* FOSSILE); or ALKALI (MARINE). This is a ſaline, alkaline, fixed ſubſtance, ſerving as a baſis to the acid of common ſalt, and forming with it the native neutral ſalt which is diſſolved in large quantities in the ſea, and known by the names *Common Salt* and *Sea-Salt*. As this ſalt is a natural production, and belongs neither to the vegetable nor animal kingdoms, it has been ranged amongſt minerals, and therefore called mineral alkali: notwithſtanding that a conſiderable quantity of this ſalt may be obtained from the aſhes of ſeveral vegetables. But its origin is always the ſame, and it is not to be conſidered a vegetable ſubſtance; for we ſhall ſee that mineral alkali obtained from vegetables, proceeds always from common ſalt contained in theſe vegetables. After we have mentioned the properties of this alkali, we ſhall deſcribe the method of procuring it in its greateſt purity.

Fixed mineral alkali has eſſentially and fundamentally all the properties of fixed vegetable alkali. It has the ſame taſte and the ſame fixity. It diſſolves all the ſame ſubſtances, and exhibits with them very ſimilar phenomena. It melts and vitrifies all earths, and is altered by quicklime in the ſame manner. It combines with all acids to the point of ſaturation, and with them forms neutral ſalts. It has the ſame action as fixed vegetable alkali on metallic ſubſtances, and forms ſoaps with oils and oily matters; therefore, in order to have a juſt idea of the alkaline properties of this ſaline ſubſtance, it is very neceſſary to read carefully and entirely what has been ſaid under the articles ALKALI *and* ALKALI (FIXED VEGETABLE). But it alſo differs very conſiderably from fixed vegetable alkali by ſeveral properties peculiar to it; and it is upon theſe properties we are chiefly to inſiſt in this article.

Fixed mineral alkali, which we here ſuppoſe to be in its greateſt purity, differs from fixed vegetable alkali,

1. By its taſte, which is a little leſs fiery and corroſive: but this difference is very ſlight.

2. When dried, it does not attract the moiſture of the air ſufficiently to form a liquid, as fixed vegetable alkali does.

3. If it be diſſolved in water, when it is dry and calcined, it does not heat the water nearly ſo much.

4. When diſſolved in water, and its ſolution evaporated and cooled, it coagulates into cryſtals, preciſely as neutral ſalts do. In this it differs conſiderably from fixed vegetable alkali, which is abſolutely deliqueſcent, and not cryſtallizable. *(k)*

The cryſtals of mineral alkali contain much water, and have but little adheſion to this water; for moſt of it is diſſipated by expoſure to open air. By this diſſipation of water the cryſtals loſe their form and tranſparency, which were owing, as of all neutral ſalts, to the water contained. *See* CRYSTALLIZATION.

Cryſtals of mineral alkali thus deprived of their water, fall into a white powder: therefore, to preſerve them, they muſt be put into bottles as ſoon as they are drained.

The differences related betwixt the vegetable and mineral alkalis ſhew that this latter poſſeſſes ſaline properties in a leſs eminent degree; which probably proceeds from the abundancy of its earthy principle.

5. Fixed mineral alkali diſſolves by fuſion, and vitrifies all earths like the vegetable alkali. But it has been obſerved, that it vitrifies earths better, and renders the glaſs more ſolid and durable. Probably this proceeds from the greater fixity of the mineral alkali, from its containing an earth leſs combined, and alſo from its want of the deliqueſcent quality.

6. With vitriolic acid, mineral alkali forms a neutral cryſtallizable ſalt called *Glauber's ſalt*, which differs from vitriolated tartar in the following circumſtances. 1. Its cryſtals are of a different figure and larger ſize. 2. They contain more water. 3. They are more ſoluble in water. 4. Their adheſion to the water of their cryſtallization is leſs, inſomuch that this ſalt by expoſure to air loſes its water, and conſequently its form and tranſparency, and becomes a white powder, as the mineral alkali does alſo when expoſed to air. *See* SALT *of* GLAUBER. As the ſame acid is in Glauber's ſalt and in vitriolated tartar, the differences above related muſt proceed from their alkaline

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(k) We have obſerved in a note upon the former article, that fixed vegetable alkali is cryſtallizable by expoſure to ſeveral kinds of gas.

baſes:

baſes: therefore all the properties which diſtinguiſh Glauber's ſalt from vitriolated tartar are to be conſidered as the differences betwixt the vegetable and mineral alkalis. The ſame obſervation may be applied to all combinations of mineral alkali with the other acids, of which we are now going to ſpeak.

7. With nitrous acid, mineral alkali forms a particular kind of nitre, ſuſceptible of detonation and of cryſtallization; but it differs from ordinary nitre, or that which has for its baſe fixed vegetable alkali, in the figure of its cryſtals, which, inſtead of being like long needles, are ſolids, each of which has ſix rhomboidal faces; that is to ſay, two angles of each face are acute, and the other two obtuſe. This figure, which is ſomewhat ſimilar to that of a cube, has occaſioned this ſalt to be called *cubic* or *quadrangular nitre*. This figure is cauſed by the mineral alkali. *See* NITRE (QUADRANGULAR).

8. With marine acid, mineral alkali forms common ſalt, the cryſtals of which are perfect cubes. This ſalt differs from the neutral ſalt formed by the combination of the ſame acid with vegetable alkali chiefly by its taſte, which is infinitely more agreeable. *See* SALT (COMMON).

9. Mineral alkali forms with the acid of vinegar a neutral ſalt entirely different from the *terra foliata tartari*, which is deliqueſcent and not cryſtallizable, while the former cryſtallizes well, and does not attract the moiſture of the air. This ſalt has no particular name. *See* SALT (NEUTRAL) *Compoſed of the* ACID *of* VINEGAR *and of* MINERAL ALKALI.

10. With the concrete tartareous acid, mineral alkali forms a neutral cryſtallizable ſalt, differing from that made with the ſame acid and vegetable alkali, or *vegetable ſalt*, by the figure of its cryſtals, which are alſo much larger and finer. This ſalt is called *Salt of Saignette*. *See* SALT *of* SAIGNETTE.

11. Mineral alkali very well diſſolves oils and oily matters, and with them forms ſaponaceous compounds, as the vegetable alkali does. But ſoaps made with this latter alkali remain ſoft, and do not acquire ſuch conſiſtency and hardneſs as thoſe made with mineral alkali. This difference is certainly cauſed by the property which mineral alkali has of cryſtallizing. *See* SOAP. (*l*)

(*l*) The difference mentioned in the text does certainly not proceed from the cryſtallizing quality of mineral alkali; for this

It is probable, that if we were to examine attentively the combinations of marine alkali with ſulphur and metallic ſubſtances, ſenſible differences might be diſcovered from ſimilar combinations made with vegetable alkali. The diſcovery of theſe differences could not fail to throw new light upon the nature of this alkali. But I do not believe that ſufficient experiments have been made on this ſubject. *(m)*

Several celebrated chemiſts have, however, made conſiderable reſearches into the nature of marine alkali. The perſon who has done moſt in this way is M. Duhamel de Monceau, a member of the Academy of Sciences. He has publiſhed in ſeveral memoirs, a detail of many experiments made to decompoſe common ſalt, that he might obtain the alkaline baſis ſingle and pure, for the purpoſe of examining its properties. Common ſalt not being capable of decompoſition merely by the action of fire, and without the application of another ſubſtance, it was neceſſary to find ſome ſubſtance which could carry off the marine acid, without combining itſelf with the alkaline baſis. As phlogiſton produces this effect very well on thoſe neutral ſalts which are compoſed of a fixed alkali and vitriolic or nitrous acids, it was natural to try the ſeparation of the marine acid by the ſame intermediate ſubſtance. This M. Duhamel did, but without ſucceſs; although in his experiment he employed every reſource of the moſt enlightened chemiſtry. The ſame thing happened to Mr. Margraaf, who tried without ſucceſs to combine marine acid with phlogiſton, in order to produce phoſphorus. It appears, then, that art does not yet furniſh any method of decompoſing common ſalt by phlogiſton.

It is nevertheleſs probable that this decompoſition is not impoſſible, and that it even takes place every day in the combuſtion of maritime plants of the *kali* kind, all of which contain ſea-ſalt, and when burnt, furniſh a conſiderable quantity of cryſtallizable alkali, which being combined with

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ſalt cannot be formed into a hard ſoap till it has been deprived of its cryſtallizing quality by quicklime, which, by abſorbing its gas, renders it cauſtic, and incapable of forming cryſtals. *See* Gas. The greater hardneſs of ſoaps made with mineral alkali than of thoſe made with vegetable alkali, probably proceeds from that property of mineral alkali by which it has a weaker power of combination with water than vegetable alkali has.

(*m*) A remarkable difference has been obſerved by Margraaf between the mineral and vegetable alkalies; namely, that platina may be precipitated from its ſolution in aqua regia by the latter, but not by the former.

the vitriolic and nitrous acids forms Glauber's ſalt and cubic nitre, entirely ſimilar to thoſe formed from the decompoſition of common ſalt by theſe two acids. It is very probable that this cryſtallizable alkali obtained from the aſhes of maritime plants, proceeds from a portion of ſea-ſalt contained naturally in theſe plants, a part of which is decompoſed by the burning; for it is certain that no trace of a diſengaged alkali can be obſerved in theſe plants previouſly to their incineration.

However that be, it is certain that this cryſtallizable alkali obtained from the aſhes of maritime plants, is entirely of the ſame nature as the natural alkaline baſis of ſea-ſalt. This is a truth which no chemiſt queſtions. But diſputes have ariſen concerning the ſaline alkaline nature of this ſubſtance.

The inquiries of M. Duhamel had proved to him, that it had the principal marks of a ſaline alkali; he concluded that it really was ſuch. On the contrary, the celebrated Mr. Pott, who has alſo made many experiments on this matter, has always maintained that it was only a pure earth, without the properties of an alkaline ſalt. This diverſity of ſentiments has occaſioned a literary diſcuſſion betwixt theſe two learned gentlemen, of that kind which always turns out to the advantage of ſcience; as it has occaſioned a great number of beautiful experiments, which greatly illuſtrate this matter.

The ſtrongeſt proof brought by Mr. Pott in ſupport of his opinion, may be found in the Eclairciſſements given to the ſequel of the French tranſlation of his Lithogeognoſia. Mr. Pott ſays, " that by a fixed or volatile alkali an inſipid " and perfectly inſoluble earth may be precipitated from " the mother water of ſea-ſalt. This earth united to the " vitriolic acid forms a Glauber's ſalt perfectly ſimilar to " that prepared from ſea-ſalt. This Glauber's ſalt produces " with charcoal a ſaline alkaline body, which is not preci-" pitable by fixed vegetable alkali; which alſo happens " preciſely to Glauber's ſalt prepared with ſea-ſalt. This " alkaline ſalt is not produced by the vitriolic acid, nor by " the charcoal, but principally from this ſaline earth, " which for that reaſon may be called an *alkaline earth*, " nearly approaching a ſaline ſtate, and which is capable " of taking from acids a proper portion of their moſt ſubtle " parts, by combination with which it becomes a genuine " alkali."

As to what remains, it appears that, after the properties of fixed alkaline ſalts and of the baſis of ſea-ſalt have been eſtabliſhed, it is eaſy to decide the queſtion. Nothing can be ſaid more ſenſibly on this ſubject than the following quotation from the learned and judicious tranſlator of Mr. Pott's Lithogeognoſia. "This queſtion is now reduced to "a diſpute about words, ſince Mr. Duhamel agrees with "Mr. Pott, that the baſis of ſea-ſalt differs from the fixed "alkali of nitre and others ſimilar; and that Mr. Pott "agrees with Mr. Duhamel, that it differs from common "abſorbent earths. But hitherto it ſeems that Mr. Duhamel's expreſſion is more juſt and conformable to the de-"finition of ſaline ſubſtances."

From all this we ought to conclude, that the baſis of ſea-ſalt is neither a pure earth, nor an alkali ſimilar to that obtained from vegetables, but a ſaline alkaline ſubſtance of a peculiar nature; and if conjectures may be allowed on the nature of this alkali, I ſhould be inclined to believe, that it differs from the vegetable alkali, either becauſe a larger quantity of earth enters into its compoſition, or becauſe its earthy principle is united to it more intimately.

Further, it appears that the baſis of common ſalt is truly of a ſaline nature, from its ſucceſsful and even advantageous application to all the ſame purpoſes in the arts as fixed vegetable alkali, as has been ſaid above.

The only practical method of procuring this alkali in great quantities is by the incineration of maritime plants. Theſe aſhes contain much mineral alkali, when the plants happen to grow in a favorable ſoil and climate, and the mineral alkali is found to be more or leſs pure, according to the nature of the plants and of the ſoil. Theſe aſhes are generally known in commerce by the name *Soda*. This ſoda is employed in arts without purification; hence there is obſerved a great difference betwixt different ſodas, ſome of which are much better than others. *(n)*

(n) Mineral alkali is found lying upon the ground in the iſland of Tenerif, and in many other countries. The Spaniſh aſhes called *bariglia*, or *ſoda*, are produced by burning kali, and perhaps ſome other maritime plants, previouſly dried, in pits dug in the ground. From theſe plants Henckel obtained, by boiling in water, evaporating and cryſtallizing, a conſiderable quantity of marine ſalt. Stahl, Gellert, and other authors, prefer this ſalt to vegetable alkali, for the formation of glaſs, which

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As the chemical affinities and the medicinal virtues of the mineral and of the vegetable alkalis are the ſame, we proceed to mention what is moſt material on theſe ſubjects.

The *affinities of fixed alkali*, according to Mr. Geoffroy's Table, are in the following order: vitriolic acid, nitrous acid, marine acid, vinegar, ſulphur.

Mr. Gellert's Table is more extenſive, and is as follows: Phlogiſton, vitriolic acid, nitrous acid, marine acid, vegetable acid, zinc, iron, copper, lead, tin, regulus of antimony, regulus of cobalt, arſenic and biſmuth. Gold and ſilver are marked in this Table as indiſſoluble by fixed alkali.

As fixed alkalis are the greateſt abſorbents of acids, they are proper for all thoſe maladies deſcribed by Boerhaave as proceeding from a ſpontaneous acid. They are even preferable to abſorbent earths, (although theſe latter are more frequently uſed) in caſes where, notwithſtanding ſigns of acidity, a putreſcent diſpoſition is apprehended; which is not at all impoſſible, becauſe they are, like all ſaline matters, antiſeptic, according to the obſervations of Dr. Pringle. But if the putridity was advanced to alkaleſcency, which is very rare, they would be very hurtful, becauſe they would increaſe this alkaline acrimony.

It muſt not be ſuppoſed that fixed alkalis taken internally, enter the blood-veſſels with their alkaline qualities. If that happened, they would be true poiſons, as acids are; ſince they quickly kill animals into whoſe veins they are injected.

The human conſtitution, which cannot ſuffer the preſence of any ſenſible and diſengaged acids or alkalis, at leaſt to a certain degree, in our fluids, acts upon alkalis taken internally by combining them in digeſtion with the acids of aliments, or with their oily parts, forming ſoaps, in which conditions only they can arrive at the blood.

Pure alkalis ought never to be preſcribed but in ſmall doſes, as from half a grain to two grains, when they are

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they pretend it makes more durable and leſs liable to be attacked by acids. But Kunckel obſerves, that the impurities mixed with common ſoda, or bariglia, give a bluiſh color to glaſs, and render it liable to crack, when cooled. Stahl obſerves, that the ſame effect is produced by common pot-aſh. I have obſerved that every kind of fixed alkali, however well refined, gives a blue caſt to glaſs, which requires to be corrected by Manganeſe. The mineral alkali, as has been obſerved in the text, makes a finer, harder ſoap than vegetable alkali. It is alſo ſaid to be more effectual in the reduction of metallic calxes.

incorporated with ſolid medicines and in ſmall bulk; but they may be given from one to ſix grains, if they be diluted, on account of their cauſticity, in a pint of ſome watery vehicle. Theſe ſaline ſubſtances are diſſolving, aperitive, and lithontriptic. They are not much employed for theſe qualities; but are principally uſed to correct reſinous purgatives, which they do very well, by giving to theſe medicines a ſaponaceous quality. Externally applied, theſe alkalis are reſolvent, diſcutient, and cauſtic. *(o)*

ALKALI (VOLATILE). Volatile alkali is a ſaline ſubſtance procured by decompoſition, from all animal, and from ſome vegetable ſubſtances, and by putrefaction from all theſe matters. *(p)*

(o) Dr. Smith, in a treatiſe *de motu muſculari*, relates an extraordinary fact, which he affirms to have aſcertained by repeated experiments, namely, that of the many ſubſtances which he mentions, acid, alkaline, and corroſive, mineral alkali and compounds formed of it were alone capable of ſtimulating or irritating the muſcles of frogs, by immediate application to theſe muſcles, which were expoſed for the ſake of making theſe experiments.

(p) The plants from which volatile alkali is obtainable by diſtillation are chiefly of the cruciform kind. This alkali is obtained by diſtilling all kinds of clays, (as Brandt ſays) many calcareous earths, chiefly that kind called Lapis ſuillus, and ſome mineral waters. Sal ammoniac, which contains volatile alkali, is ſublimed in volcanos. Sal ammoniac may be produced from ſoots of burning vegetable or animal ſubſtances, and even of mineral coals. Authors mention various methods by which volatile alkali may be produced. As a knowledge of theſe may aſſiſt us to form a theory concerning this ſaline ſubſtance, we ſhall relate ſome of them. Volatile alkali may be produced by heat, 1. From a mixture of quicklime with vitriol, or with alum, or with tartar. *Pott.* 2. From a mixture of any eſſential oil with vitriolic acid and fixed alkali. *Id.* 3. From nitre detonating with charcoal. *Id.* 4. From a combination of marine acid with quicklime. *Id.* 5. From magneſia alba by diſtillation. *Dr. Black.* 6. From tartar. *Id.* 7. From deliquiated ſalt of tartar poured on white ſalt of vinegar. *German Ephemerides, Pott, Ludovici, and Hoffman.* 9. From ſea-ſalt combined with putrifying ſubſtances. *Pott.* 10. From ſea-ſalt diſtilled with charcoal. *Id.* 11. From ſea-ſalt diſtilled with quicklime. *Id.* 12. From ſalt of Sylvius diſtilled with fixed alkali. *Beck and Peterman.* 13. From ſea-ſalt diſtilled with clay. *Brandt.* 14. From ruſt of iron diſtilled. *Bourdelin.*

This ſaline ſubſtance is called *alkali*, becauſe in fact it has all the general properties of ſaline alkalis, as the ſharp, cauſtic and burning taſte; the property of tinging violets with a green color; of combining with acids to the point of ſaturation, and forming with them different neutral ſalts, moſt of which are cryſtallizable; of ſeparating all earthy and metallic matters from their union with acids; laſtly, of diſſolving by the humid way, almoſt all ſubſtances ſoluble by other alkalis.

This alkali is called *volatile*, becauſe in fact it is very much ſo. Its volatility is owing to a portion of attenuated, very ſubtle, and very volatile oil, which enters into its compoſition as one of its principles, as is proved by its diſtinguiſhing properties.

Volatile alkali differs according to the ſubſtances whence it is procured, and according to the manner of obtaining it. Theſe differences proceed from ſome principles ſuperabundant and extraneous; particularly, ſeveral oils from which it is not at firſt exactly depurated. But all volatile alkalis, however obtained, and from whatever ſubſtances, may be ſo purified by the method which ſhall be ſoon deſcribed, that no difference remains amongſt them; and hence we ought to conclude of this ſubſtance, as well as we did of the various kinds of fixed alkali, that it is ſingle, identical, and always ſimilar to itſelf, when ſufficiently purified.

Pure volatile alkali differs from fixed alkali, firſt, by its greater volatility, which is ſo great that it may be entirely ſublimed or diſſipated by a heat much leſs than the heat of boiling water; by its ſmell, which is only an effect of its volatility: the ſmell of this ſalt is ſtrong, very penetrating, and ſo pungent, that it cannot be endured above an inſtant, without ſuffocation or fainting; its vapor excites a cough, and brings tears into the eyes. It is this ſalt which occaſions the pungent ſmell obſerved in neceſſary-houſes at changes of weather.

This alkali differs alſo from the fixed by its leſs force; hence fixed alkalis are capable of decompoſing all thoſe ſalts whoſe baſes are volatile alkali, of ſeparating it from theſe ſalts, and of ſetting it at liberty.

Volatile alkali unites perfectly with water, to which it has even a ſtrong affinity, and with it retains fluidity: it is then called volatile alkaline ſpirit. When it contains no ſuperabundant water, it is in a concrete form, and is cryſtallized, in which it differs from fixed vegetable alkali. *(q)*

All acids unite and effervefce with volatile alkali to the point of ſaturation, forming neutral ſalts, generally called *ammoniacal ſalts.*

Ammoniacal ſalts have an infinitely ſtronger and more pungent taſte than ſalts whoſe baſes are fixed alkali, becauſe volatile alkali unites with acids leſs intimately. Theſe neutral ſalts are ſemi-volatile; that is, they may be ſublimed by a ſufficiently ſtrong heat; and this property they owe to the volatility of their alkaline baſis.

The ammoniacal ſalt which volatile alkali forms with vitriolic acid is cryſtallizable, and is called *vitriolic ammoniacal ſalt*, or *ſecret ammoniacal ſalt of Glauber*, from the name of the chemiſt who diſcovered it. *See theſe words.*

The kind of nitre formed by volatile alkali and nitrous acid is alſo cryſtallizable, and has the peculiar property of detonating alone, when heated ſufficiently, without addition of any matter containing phlogiſton, as is neceſſary for the detonation of ordinary nitre. This phenomenon proves the exiſtence of the inflammable principle in volatile alkali. This nitre, whoſe baſis is volatile alkali, is called *ammoniacal nitre*, or *nitrous ammoniacal ſalt. See theſe words.*

With marine acid, volatile alkali forms alſo a neutral cryſtallizable ſalt, called *Sal Ammoniac.* This is the moſt uſed, and firſt known of the ammoniacal ſalts, and from which the name has been derived to the others. *See* SAL AMMONIAC.

Volatile alkali may be combined with ſulphur, with which it forms a kind of volatile liver of ſulphur, the preparation of which is given by Hoffman. *See* LIVER *of* SULPHUR.

Moſt metallic matters are attacked, and more or leſs diſſolved by volatile alkali; but copper is of all metals the moſt eaſily and copiouſly diſſolved by it. To diſſolve this metal, nothing more is requiſite than to digeſt its filings in liquid volatile alkali. The ſolution acquires a beautiful blue color.

This ſolution exhibits a curious and intereſting phenomenon, which is, that if the bottle containing it be well

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(q) Volatile alkali, by combination with gas or fixable air, is cryſtallizable; uncombined, it cannot be obtained in a ſolid ſtate.

corked, the blue color grows fainter, and at length entirely diſappears, ſo that the liquor becomes colorleſs like water. But if the ſame bottle be then uncorked, the upper part of the ſolution from its contact with the external air reſumes its color, and this color is gradually communicated to the reſt of the liquor. Thus may this blue color be made to appear and diſappear alternately, as often as is required, by corking and uncorking the bottle.

Other metallic matters are not nearly ſo eaſily attacked by volatile alkali as copper is. Theſe ſolutions have even not been much examined.

When metals are previouſly diſſolved and divided by acids, they are then infinitely more ſuſceptible of ſolution by volatile alkali. For this purpoſe it is ſufficient to pour into ſome ſtrong alkaline ſpirit ſome drops of metallic ſolution. At firſt a precipitate is formed, which ſoon diſappears upon agitating the liquor, and is rediſſolved by the volatile alkali. That this experiment ſhould ſucceed, it is neceſſary that the metallic ſolution ſhould have a conſiderable exceſs of acid; that is, that the acid ſhould not be nearly ſaturated with the metal. By this method, copper and mercury are diſſolved in greater quantity than other metals.

In whatever manner the copper be diſſolved by this ſalt, it always communicates a blue color, very beautiful and deep. This property renders the alkaline ſpirit a proof liquor to diſcover copper, and render it ſenſible when it could not, from the ſmallneſs of its quantity, be perceptible by other methods. Thus a little volatile alkali may be poured into any mineral water, containing too ſmall a quantity of copper to be otherwiſe perceptible. The blue color which this water aſſumes diſcovers the preſence of copper.

Volatile alkali, added gradually to a metallic ſolution, ſeizes the acid of the ſolution, and precipitates the metal. The moſt ſingular metallic precipitate made by volatile alkali is that of gold previouſly diſſolved in aqua regia. This precipitate is of a yellow color, and is one fourth part heavier than the gold employed. When heated to a certain degree, it detonates and fulminates with a moſt terrible exploſion. It is called *fulminating gold*. *See* GOLD (FULMINATING).

Mercury diſſolved in ſpirit of nitre, and precipitated by volatile alkali, is of a ſlate color. This color proceeds from the inflammable matter of the volatile alkali. The other metallic precipitates made by volatile alkali have nothing ſingular: none of them fulminates like the precipitate of gold; even that of platina does not, though this metal poſſeſſes ſo many of the properties of gold. *(r)*

Volatile alkali, as well as fixed, acts upon oils, and forms with them different ſaponaceous compounds; hence this ſalt may be employed to ſcour and clean from greaſe; and lixiviums made of quicklime and urine, which contain much volatile alkali, are uſed in ſome arts. This alkali is, however, leſs eaſily united with oils than fixed alkali is, and particular management is neceſſary to bring it to a ſaponaceous ſtate. *See* SPIRIT (VOLATILE AROMATIC OILY); *and* EAU DE LUCE. Theſe are the principal ſaponaceous compounds made with volatile alkali.

Volatile alkali, when firſt ſeparated from animal and vegetable matters, is, as we before obſerved, very impure. It is particularly depraved by much empyreumatic oil, which is united with it into a ſtate perfectly ſaponaceous, and which it renders ſoluble in water. It may be ſeparated from this ſuperfluous oil by diſtilling it with a very gentle fire, either alone, or mixing with matters capable of abſorbing and retaining the oil, as fixed alkalis and abſorbent earths are. But the moſt efficacious method of purifying it is, to reduce it to ſal ammoniac, and then to decompoſe this ſalt, by any of the proper mediums for the diſengagement of the volatile alkali. By this method it is obtained in its greateſt purity; becauſe, in its combination with the acid, it perfectly ſeparates itſelf from all extrane-

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(r) From Mr. Margraaf's Experiments, publiſhed in the Berlin Memoirs for the year 1745, we find that gold, ſilver, biſmuth, zinc, and copper, diſſolved in their proper acid ſolvents, may be firſt precipitated from theſe, and afterwards rediſſolved by volatile alkali; that theſe metals precipitated by fixed alkalis may be again diſſolved by volatile alkali; and that mercury, lead, and tin, were not diſſolved by volatile alkali applied in the ſame manner. Brandt ſays, that volatile alkali occaſions a coagulation of a ſolution of iron in nitrous acid, which is ſoon rediſſolved; and that the ſame alkali precipitates iron from vitriolic acid. He alſo ſays, that regulus of cobalt cannot be precipitated from nitrous acid, nor arſenic from aqua regia, by volatile alkali. Volatile alkali has no effect upon any metal not previouſly diſſolved by acids, excepting copper, iron, and lead; the firſt of which it diſſolves perfectly, a very ſmall quantity of the ſecond, and the third is very ſlowly changed by it into a kind of mucilage. *See* POTT *ſur la Diſſolution des Corps.*

ous matter. *See* SAL AMMONIAC, *for the purification of volatile alkali, and for ſeveral of its eſſential properties.* (*s*)

The affinities of volatile alkali, according to Mr. Geoffroy's Table, are, vitriolic acid, nitrous acid, and marine acid. According to Mr. Gellert's Table they are, phlogiſton; vitriolic, nitrous, and marine acids; vinegar; zinc; iron; copper; biſmuth; mercury; ſilver; and gold.

Volatile alkali is employed in medicine as a powerful ſtimulant and exciter, when applied ſo that the perſon ſhall inhale the vapors of it. Thus it is applied in faintings, ſyncopes, apoplexies, and in all lethargic diſeaſes, in which the nervous parts are benumbed and unbraced. In theſe caſes it is uſually applied in bottles, either in a concrete form called *Engliſh Salt*, or in a fluid form, and reduced to a ſemi-ſaponaceous ſtate by mixture with oil of amber, when it is called *Eau de Luce*. *See* SALT (ENGLISH); *and* EAU DE LUCE.

It may alſo be taken internally in theſe caſes, particularly in apoplexies and lethargic diſeaſes, but in ſmall doſes, as from two or three grains to ſix, and added to ſtimulant mixtures. Taken in this manner, it ſometimes is a powerful ſudorific.

M. Bernard de Juſſieu has diſcovered that this ſaline ſubſtance is a ſpecific againſt the bite of vipers; having cured as it were miraculouſly, by means of eau de luce, a ſtudent of medicine, to whom this accident happened, while he was botanizing.

ALKALISATION. This name is applied to operations by which alkaline properties are communicated to bodies; or to thoſe by which alkali is extracted from bodies which contain it, or in which it may be formed. For example, *ſpirit of wine* is ſaid to be *alkaliſed* when it has been digeſted upon alkali, a part of which it diſſolves, and

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(*s*) To the properties above-mentioned of volatile alkali, we may add, 1. That pure or cauſtic volatile alkali, that is, when the volatile alkali is uncombined with gas or fixable air, ſuch as the ſpirit of ſal ammoniac is when obtained by means of quicklime, is ſoluble in ſpirit of wine; and that mild volatile alkali is not ſoluble in that ſpirit: hence if a ſtrong ſolution of mild volatile alkaline ſalt be added to ſpirit of wine, the water of the ſolution will combine with the ſpirit, and the ſalt will be precipitated, forming what is called *Offa Helmontii*. 2. Mild volatile alkaline ſalt requires four times its quantity of water to diſſolve it: cauſtic volatile alkali, as we have already obſerved, is always combined with water.

thence acquires alkaline properties. On the other hand, when a neutral ſalt is decompoſed in order to obtain its alkaline baſis, this ſalt is ſaid to be alkaliſed. Thus nitre, deprived of its acid by detonation with inflammable matters, as charcoal, tartar, metals, ſo that nothing remains but its alkali, is called *Nitre alkaliſed by Charcoal*, or *by Tartar*, &c.

Vegetable ſubſtances, when reduced to aſhes, may alſo be ſaid to be alkaliſed; becauſe theſe aſhes contain fixed alkali. *See the detail of particular alkaliſations, under the articles of the different* ALKALIS.

ALKOHOL. This name has been given to any impalpable powder. *See* PORPHYRISATION.

It has alſo been given to highly rectified ſpirit of wine. *See* SPIRIT *of* WINE.

ALLAY. This word is employed in chemiſtry to ſignify the union of different metallic matters.

As an infinity of different combinations may be made according to the nature, the number, and the proportions of the metallic matters capable of being allayed, we ſhall not here enter into the detail of the paricular allays, all which are not yet nearly known. Thoſe which are uſed, as *Bronze*, *Tombac*, *Braſs*, *White Copper*, &c. may be found under their particular names; and what is known concerning other allays may be partly found under the names of the different metals and ſemi-metals and partly in this article.

Metallic ſubſtances cannot unite directly with earthy matters, not even with their own earths, when deprived of their inflammable principle, and conſequently of their metallic properties. But in general it may be ſaid, that all metals may be allayed with each other, although more or leſs eaſily, and although ſome of them have not yet been made to unite.

As metals are bodies naturally ſolid, the firſt condition for their union is, that they be fuſed. They then unite, like all bodies which reciprocally diſſolve each other; and from theſe combinations new compounds reſult, which have the mixt properties of the component ſubſtances. *See* COMPOSITION (CHEMICAL).

In theſe metallic allays, as in almoſt all other metallic combinations, phenomena appear which depart from the general rules of combinations. Thus it is obſerved, that ſome of the properties of metals forming an allay are altered, increaſed, or diminiſhed by their union. The ductility,

tility, for inſtance, of a metallic compoſition is generally leſs than the ductility of the component metals alone and pure. The denſity or ſpecific gravity of metals and ſemimetals is alſo changed by allaying them with each other. Sometimes the ſpecific gravity of the compound is intermediate betwixt the ſpecific gravity of the component metals, ſometimes it is leſs, and frequently greater: this depends upon the nature of the metals. The ſame obſervation may alſo be applied to the colors reſulting from the allays of metals.

Metallic allays are either *natural* or *artificial*. The firſt are thoſe made by nature, ſuch as moſt minerals, containing ſeveral metals allayed with each other. Native gold is always more or leſs allayed with ſilver; and native ſilver with gold.

Artificial allays are thoſe made expreſly for different uſes, or for the ſake of examining their properties.

Although the allays of different metallic matters are of great importance to the theory and to the practice of chemiſtry, yet all the reſearches which the ſubject deſerves, and is capable of, have not been made. Mr. Gellert is one of thoſe who have done moſt in this way. In his *Metallurgic Chemiſtry* there are a great number of experiments, which we ſhall relate here ſummarily. The experiments made for the allaying of ſemimetals with metals are his own, and were undertaken to determine the ſpecific gravities of theſe allays. He relates the others before known, from chemical writings, and particularly from a Diſſertation of Mr. Kraaft expreſly on this ſubject. We ſhall refer the allays of mercury with other metals, called Amalgams, to the word AMALGAM.

Gold may be eaſily united with ſilver, and in all proportions. Mr. Gellert ſays, that this allay is nearly of an intermediate gravity betwixt the gravities of the two metals, and but a very little augmented. This allay is of no uſe in the arts: on the contrary, as pure metals are always more ductile than allays, in the arts where ductility is requiſite, as in wire-drawing, and gold-beating, the pureſt metals are choſen. (t)

(t) The component metals of which metallic allays are formed may be either chemically combined, that is, mutually diſſolved by each other; or mechanically mixed, that is, diffuſed through each other by the action of fire; or they may be partly combined, Silver may be eaſily allayed with copper, and in all proportions: copper alſo unites in the ſame manner with gold. Gellert

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and partly diffuſed, if the proportion of their quantities to each other be different from that which is neceſſary for their combination. For moſt, if not all, metals can be only combined with each other in certain proportions, as is very obſervable in thoſe, the fuſion of which requires very different degrees of heat. But thoſe which may be kept fuſed in nearly the ſame degrees of heat, may be *mixed* together in almoſt any proportion, and will be nearly uniformly diffuſed throughout the metallic maſs when haſtily cooled. As metallic allays have not been before conſidered in this manner, no experiments have been made to determine the proportions with which they can combine; nor can we eaſily eſtabliſh rules by which this kind of combination can be aſcertained. Thoſe, however, which appear to be moſt probable, for diſtinguiſhing this combination, are, 1. When an allay poſſeſſes properties which neither of its component metals had. 2. When the properties, as the ſpecific gravity, color, hardneſs, &c. of the allay, are not in an intermediate degree betwixt the ſame properties of the component metals, according to the proportion of theſe metals to each other. 3. When the component parts of an allay are not ſeparable from each other by eliquation; that is, by applying a heat capable of fuſing one of them only; nor by keeping the whole maſs in fuſion, with a heat not more intenſe than is neceſſary for that purpoſe, but inſufficient to occaſion an ebullition, and by cooling the melted maſs very ſlowly. When therefore, according to theſe rules, a metallic allay has no properties but thoſe which its component metals had; when its denſity, color, hardneſs, elaſticity, fuſibility, and other properties, are preciſely in an intermediate degree betwixt thoſe of its component metals; and laſtly, when its component metals may be ſeparated from each other by eliquation, or by giving them ſuch a fluidity and reſt as that they may ſeparate according to their reſpective denſities; we may then, with probability, pronounce that this allay is compoſed of parts not chemically combined: and when to an allay, which by theſe rules is compoſed of metals chemically combined, a quantity of one of the ſame kinds of metal of which the allay was compoſed, is added, and, upon examination, the new allay is found to poſſeſs no properties but ſuch as are intermediate betwixt the firſt allay and the added metal, and to be ſeparable by eliquation, or by fuſion according to their different denſities, we may then conſider this new allay as a maſs conſiſting of metals partly combined, and partly diffuſed. That the allay mentioned in that part of the text to which this note refers, namely, that of gold with ſilver, does not conſiſt of parts chemically combined, or elſe, that but a very ſmall proportion of either of theſe metals can be

Gellert obſerves, that the allay of ſilver and copper is of a greater than the intermediate gravity; but that the allay of gold and copper is of a gravity leſs than intermediate. Copper renders gold and ſilver harder and more ſonorous, without much diminution of their ductility. It has even the remarkable property of rendering theſe two metals leſs ſuſceptible of loſing their ductility by the vapor of charcoal, which they are very liable to do; copper alſo heightens the color of gold. Theſe properties of copper relatively to gold and ſilver render its allay with theſe metals of great uſe to gold and ſilver ſmiths; becauſe it makes theſe metals firmer, and fitter for working and chaſing; and alſo for making money, for the ſame reaſons; and for the payment of the duties of Government, and for compenſation of the expences of coining. The quantity of copper allayed with gold and ſilver for theſe different uſes varies according to the different countries, but in each country it is fixed, and always the ſame.

Iron allays well with ſilver, and ſtill better with gold. Gellert obſerves, that the gravity of an allay of gold and iron is leſs than the intermediate. The affinity of theſe two metals is very great; for gold facilitates its fuſion, which indicates a ſtrong diſpoſition to unite. Gellert obſerves upon this occaſion, that therefore gold is fitter than copper for ſoldering fine works of iron and ſteel. (u) Iron unites difficultly

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combined with the other, appears probable from the following reaſons: 1. The denſity of the allay is very nearly intermediate between the denſities of the component parts. 2. The ſilver and gold are not uniformly and equally diſtributed through the whole maſs. This inequality is proved by an experiment of Mr. Hellot. He melted a maſs of 20 pounds, containing 55 parts of ſilver and one part of gold, and poured it into three ſeparate maſſes, each of which was found by eſſay to contain a different proportion of gold from the two others. 3. Gold and ſilver kept in gentle fuſion are ſeparable from each other, merely by means of their different denſities. Mr. Homberg kept equal parts of gold and ſilver in gentle fuſion a quarter of an hour, and found, upon breaking the crucible, two maſſes, of which the upper was pure ſilver, and the lower the whole gold allayed with $\frac{1}{6}$th part of ſilver. He repeated the experiment with nearly the ſame event; and twice he obtained the two metals perfectly ſeparated from each other. *See a note to the article* AFFINITY.

(u) A very ſmall quantity of iron renders gold hard, brittle, and pale. So hard are ſome mixtures of iron and gold, that they are difficultly with copper, and in ſmall proportion. It renders copper paler. The portion of iron which does not unite with copper forms a ſeparate regulus, which, however, ſtrongly adheres to the ſurface of the regulus of copper. The degrees of affinity of iron with other metals, according to Gellert's Table, but reverſing the order in which he has placed them (that is to ſay, beginning by thoſe with which it has the ſtrongeſt affinity, which ſeems to be the moſt natural order), are, gold, ſilver, and copper.

Tin, according to the ſame author, unites with all metals, and renders them brittle; iron and lead it alters leaſt in this reſpect. *(w)* But gold and ſilver are ſo affected by tin, that its vapor alone is capable of deſtroying the ductility of a large quantity of theſe metals, as is well known to artificers.

The allays of tin with gold and ſilver are therefore of no uſe; on the contrary, they are carefully avoided; but with copper tin forms an uſeful compound, known by the name of *Bronze*. The ſpecific gravity of allays of ſilver and of copper with tin is greater, and that of gold with tin is leſs than the intermediate. The affinities of tin with other metals, according to Gellert's Table (only reverſing his order, which we ſhall always do), are iron, copper, ſilver, gold.

Lead unites with all metals, excepting iron, with which no method has been found to unite it. Gellert obſerves, that this property of iron with regard to lead renders it fit to ſeparate this latter metal from others, provided that the metal from which it is to be ſeparated has not a greater diſpoſition to unite with lead, than the iron has to unite with it. This is certain, that lead may ſerve as an intermedium by which iron may be ſeparated from other metals: for inſtance, from ſilver. For if a ſufficient quantity of lead be melted with ſilver allayed with iron, it will eaſily ſeize upon the ſilver, and ſeparate the iron from it, which will then ſwim upon the ſurface of the two melted metals.

The allays of gold and of ſilver with lead have a greater ſpecific gravity, and the allays of copper and of tin with lead have a leſs ſpecific gravity, than the intermediate.

are ſaid to have been formed into razors. Three or four parts of iron and one part of gold compoſe an allay nearly as white as ſilver.

(w) Equal parts of tin and iron form a white but brittle maſs.

The allay of lead with other metals is uſed for the eſſays of ores, for refining, and for liquation. *See* LIQUATION.

Lead and tin are allayed together to form a ſolder for pipes and other works of lead.

The affinities of lead with other metals, according to Mr. Gellert's Table, are, ſilver, gold, tin, copper.

Zinc may be allayed with all metallic matters, excepting biſmuth, with which it cannot unite, according to Mr. Gellert. This ſemimetal, when united with metallic ſubſtances, gives fuſibility to thoſe which are leſs fuſible than itſelf. The denſity of allays of gold, of ſilver, of copper, and of lead with zinc is greater; and that of allays of the ſame ſemimetal with tin, iron, and regulus of antimony, is leſs than intermediate.

The allays of zinc with moſt metallic matters are not uſed in the arts, but that with copper is very much. This allay forms *Braſs*, *Tombac*, *Prince's Metal*, *Pinchbeck*, &c.

The affinities of zinc with other metallic matters are, according to Gellert's Table, copper, iron, ſilver, gold, tin, lead *partly*; that is, it does not unite with lead in all proportions.

Biſmuth unites with all metals, and with moſt ſemimetals. It has ſo great action upon other metallic ſubſtances, that it ſenſibly facilitates their fuſion. *(x)* Biſmuth renders all the metals with which it is united brittle. It does not unite with zinc; nor, according to Mr. Gellert, with arſenic.

(x) Biſmuth greatly increaſes the fuſibility of ſome metals, as appears from the following Table of Dr. Lewis, in which the degrees of heat are marked in numbers according to Fahrenheit's ſcale.

600. Mercury boils.
540. Lead melts.
460. Biſmuth melts.
410. Tin melts.
390. Tin 8 parts, biſmuth 1 part, melt.
330. Tin 2 parts, biſmuth 1 part, melt.
Tin 3 parts, lead 2 parts, melt.
280 Tin and Biſmuth, equal parts, melt.
212. Water boils.

Mr. D'Arcet has, in the *Journal de Medicine*, (*June* 1775) publiſhed an account of ſome experiments made to diſcover the proportions of lead, tin, and biſmuth, which ſhould produce the moſt fuſible allay. He found that a maſs conſiſting of eight parts of biſmuth, five parts of lead, and three parts of tin, melted in boiling water, and even in *balneo mariæ*.

When melted along with zinc, it remains at the bottom of the crucible, as being the heavier of the two; and when they are cooled, they are found forming two diſtinct reguli adhering ſtrongly to each other. Gold, ſilver, lead, and regulus of antimony form with biſmuth allays of greater, and iron forms an allay of leſs, than intermediate denſity, and copper forms with it an allay of intermediate denſity.

The allays of biſmuth are not in uſe, excepting ſome particular metallic compoſitions for mirrors.

The affinities of biſmuth with other metals are, according to Mr. Gellert's Table, in the following order: iron, copper, tin, lead, ſilver, gold.

" Cobalt" *, ſays Mr. Gellert, " may be allayed with " all metals and ſemimetals; but it acts little upon lead " and ſilver. When equal parts of lead and cobalt are " melted together, theſe two ſubſtances are found only " adhering to each other, the lead being, in conſequence of " its greater ſpecific gravity, at the bottom of the crucible, " and the cobalt above it; ſo that it ſeems probable that " they are not at all combined. But if the ſame cobalt be " melted, after it has been thus treated, with iron, which " ſeems to be the moſt readily united with it of all the " metals, a ſmall regulus of lead is found at the bottom of " the crucible, becauſe iron and lead do not unite. At " firſt, we might be apt to believe that ſilver and cobalt do " not unite together. In fact, if two parts of cobalt and " one part of ſilver be melted together, the ſilver is found at " bottom and the cobalt above, only adhering to each other: " But the ſilver is become more brittle, and of a greyiſh " color; and the cobalt is become whiter than before. If " this ſilver be cupelled, the part of the cobalt united with " it will attach itſelf to the cupell in form of a circle, and " the ſilver will be found to have loſt an eighth part of its " weight, which will be found upon eſſaying the cobalt, " and examining how much ſilver it contains." *Metallurgic Chemiſtry*, *Tom.* I.

Theſe experiments of Mr. Gellert's prove, that regulus of cobalt cannot be united to lead and to ſilver in all proportions, but only in ſmall quantities. The ſame may be ſaid of biſmuth, with which, ſays Mr. Gellert, cobalt is very eaſily united: for Mr. Beaumé, who has made many experiments on the regulus of cobalt, has obſerved, that when this regulus is melted with biſmuth, theſe two metals are found ſeparate, the biſmuth being at the bottom of the crucible and the cobalt above it.

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* Note. By *Cobalt* Mr. Gellert certainly means what we call Regulus of Cobalt; for Cobalt properly called is a mineral compoſed of other ſubſtances beſides the regulus of cobalt, as ſulphur, arſenic, biſmuth, ſilver, and unmetallic earths. *See* COBALT.

The allays of the regulus of cobalt are but little known, and not uſed in the arts.

In Mr. Gellert's Table, the affinities of regulus of cobalt with metallic matters are in the following order: copper, iron, tin, zinc, regulus of antimony, biſmuth and lead, ſilver, and arſenic, partly.

Regulus of antimony may be allayed with almoſt all metallic ſubſtances. Mr. Gellert ſays, that the denſity of allays of this regulus with iron, tin, or zinc, is leſs than intermediate, and that the denſity of allays of this regulus with ſilver, copper, lead, and biſmuth, is greater than intermediate. He obſerves alſo, that the magnetic property of iron is much more diminiſhed by an allay of that metal with regulus of antimony than with any other metallic ſubſtance.

Allays of regulus of antimony are little uſed in the arts. It is uſed in ſome compoſitions for ſpeculums. An allay of this ſemimetal with iron, tin, and copper, is made for the preparation of a medicine called *Lilly of Paracelſus*, or *Tincture of metals*. *See* LILLY *of* PARACELSUS.

The affinities of the regulus of antimony with metallic ſubſtances are placed by Mr. Gellert in the following order: zinc, copper, tin, lead, ſilver, gold. Biſmuth is ſo placed in the Table as to denote its incapacity of uniting with the regulus of antimony.

Arſenic, or its regulus, unites with moſt metallic matters. Mr. Gellert ſays, that it whitens iron; but the allay reſulting from thence is very brittle. Copper is alſo rendered very white by mixture with arſenic. This is the *white tombac* which reſembles ſilver. Mr. Gellert affirms, that this allay, notwithſtanding it contains arſenic, is ſufficiently ductile and malleable, which is very remarkable. But if it contain too much arſenic, it is brittle, and blackens in its ſurface. Arſenic united with tin is partly reduced to a powder like aſhes, in which much of the arſenic remains. The reſt of the tin is very brilliant, foliated, and externally reſembles zinc, without being poſſeſſed of any of its properties. Tin alſo becomes much harder and more ſonorous by this union. Lead united with arſenic ſmokes and ſwells more quickly with a moderate fire than it does alone: a part of it is diſſipated in form of a thick ſmoke; another part is changed into a glaſs of a reddiſh yellow color; and the remaining lead is brittle, and dark-colored. Arſenic unites with ſilver, and renders it brittle. It does the ſame to gold, and alſo deprives it of its color, rendering it pale. It unites very difficultly with cobalt, with which it forms a black, ſhining matter. Laſtly, Mr. Gellert (from whom all this is extracted) ſays, that biſmuth cannot be united with arſenic.

In this author's Table of Affinities, the metallic ſubſtances capable of uniting with arſenic are placed in the following order, which is the ſame as that for the regulus of antimony: zinc, iron, copper, tin, lead, ſilver, gold, regulus of antimony.

The allays of arſenic uſed in the arts are white tombacs, and ſome compoſitions for ſpeculums.

It is neceſſary to remark on the ſubject of arſenical allays, that this ſingular ſubſtance has the property of uniting with metals even when it is deprived of phlogiſton, and in an unmetallic ſtate. This proceeds from its ſaline character, and from its property of taking phlogiſton from the imperfect metals and from the ſemimetals; conſequently there ought to be a difference betwixt the allays made with white cryſtalline arſenic, and thoſe made with the regulus of arſenic. *See* ARSENIC, *and* REGULUS *of* ARSENIC. *(y)* It is proper to obſerve, that chemiſts who treat of metallic allays differ much from each other in the deſcriptions they give of the reſults of their experiments, as may be ſeen in the particular articles of each metallic matter, which ought to be conſulted on this ſubject. But theſe differences are not ſurpriſing, when we conſider the difficulty of the matter, and the great obſtacles which prevent perfect exactneſs in theſe experiments. All who have operated much in chemiſtry will eaſily perceive, that, without reckoning the difference of proportions of the metals employed in the allays, which muſt greatly affect the reſults, others much more conſiderable would occur, depending on the purity of metals, on the

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(y) The author of the Dictionary has omitted, in the enumeration of allays, thoſe of Platina, and of the ſemimetal diſcovered by Mr. Cronſtedt, called *Nickel.* For thoſe of Platina, *ſee* the article PLATINA. *Nickel* may be allayed with all metallic ſubſtances excepting ſilver, mercury, and zinc. By means of nickel the two ſemimetals biſmuth and regulus of cobalt may be united. It whitens copper and gold, and it renders the malleable metals hard and brittle.

greater or leſs quantity of phlogiſton with which many of them are capable of being united, on the very variable deſtructibility and volatility of many metallic matters; and laſtly, on the juſt degrees of heat, which are of conſiderable conſequence, and which it is almoſt impoſſible to determine preciſely.

From theſe obſervations we ought to conclude, that, in order to make a ſett of accurate experiments on metallic allays, and which may be depended upon, it is, in the firſt place, neceſſary that all the metallic matters to be employed be exceedingly pure, which is a matter of great difficulty: in the ſecond place, it is proper to make all the fuſions in veſſels perfectly cloſe, to prevent the alteration, the burning, and the deſtruction of thoſe metals which are liable to thoſe events: laſtly, to determine carefully the preciſe degree of heat requiſite for the beſt combination of metallic matters with each other. But it does not appear that any perſon has hitherto done this great and important work; it is to be wiſhed that it were undertaken. How many fine experiments might be made upon all theſe allays, to diſcover their properties!

What has been already done in this matter is, however, ſufficient to eſtabliſh ſome general truths. Several have been explained in the beginning of this article. Another evidently reſults from the experiments of M. Kraaft and M. Gellert: it is this, That as in the union of all other bodies, ſo in that of metallic ſubſtances, ſome are more eaſily ſoluble, and in all proportions; others more or leſs difficultly, and only in certain proportions; and laſtly, others appear incapable of uniting in any manner.

On theſe two latter caſes it is very important to obſerve, that this property which certain metallic matters have of diſſolving others in certain proportions only, is very capable of impoſing on the operator, and of perſuading him that one metal cannot be united with another, becauſe he ſees after the fuſion two diſtinct reguli, while in fact there is a quantity, though frequently a very ſmall one, of one of the metals united with the other. This is ſimilar to what happens in the combination of ſpirit of wine with oils, and of water with ether. Chemiſts believed long that ether was inſoluble in water, becauſe when theſe two liquors were put in the ſame veſſel they conſtantly ſeparated, the ether, being greatly the lighter of the two, riſing upwards, and floating on the ſurface of the water. But the Count de Lauragais, having examined the matter more attentively, and in a truly chemical manner, demonſtrated, in a memoir read at the Academy of Sciences, of which he is a member, that ether is really ſoluble in water, but only in a certain proportion. *See* ETHER. This being eſtabliſhed, perhaps we ſhould find, if we were to examine all the mixtures of metallic ſubſtances, that thoſe which have hitherto been conſidered as incapable of union are, nevertheleſs, very capable of it, but only in certain proportions; and if ſome are found which cannot by ordinary fuſion be united, we might ſtill try to break their aggregation more compleatly, and then to apply them to each other, as the Count de Lauragais has done with ſulphur and ſpirit of wine. *See* COMBINATION; COMPOSITION (CHEMICAL).

ALUDELS. Chemiſts give this name to certain pots or capitals which are open at both the upper and lower ends, and may be inſerted and applied above each other, ſo that the whole ſhall form a pipe or tube more or leſs long according to the number of aludels compoſing it. The aludel which terminates this tube above, ought to be cloſed in its upper part, or to have but a very ſmall opening. The tube compoſed of theſe aludels is nothing but a kind of capital or head, which may be enlarged or lengthened at pleaſure, and adapted to a cucurbit. This apparatus is intended to collect and retain dry and volatile matters, which may be reduced into flowers by ſublimation. It may be employed for the preparation of flowers of ſulphur, of arſenic, of antimony, of benjamin, &c. *See* SUBLIMATION. *See alſo* PLATE I.

ALUM. Alum is a cryſtallizable ſalt compoſed of vitriolic acid united with an argillaceous earth. This ſalt has an auſtere, ſweetiſh, and ſtrongly aſtringent taſte. This ſtrong taſte proceeds from the ſtrength of union betwixt the acid and its baſe being leſs than in other vitriolic ſalts with earthy baſes; ſuch, for example, as ſelenites, which has no ſenſible taſte. Mr. Beaumé has even obſerved, that the acid of alum is not exactly ſaturated; for it is certain that it reddens turnſol and blue paper.

This ſalt diſſolves ſufficiently well in cold, but in much larger quantity in boiling water. (z) It is conſequently ſuſceptible of cryſtallization by the evaporation and cooling of the water in which it is diſſolved. The figure of the cryſtals of this ſalt varies, like that of other ſalts, according to the circumſtances concurring during the cryſtallization. When its ſolution, evaporated to the cryſtallizing point, is made to cool ſlowly, the greateſt part of its cryſtals are found to be triangular pyramids, whoſe four angles ſeem cut off. Alum retains half its weight of water in cryſtallizing.

(z) Neuman ſays, that alum requires ten times, and other authors ſay it requires fourteen times, its weight of water to diſſolve it.

This great quantity of water in the cryſtals of alum, together with its property of greater ſolubility in hot than in cold water, is the cauſe that when put in an earthen or iron veſſel, on a good fire, it enters into a liquefaction, which gradually diminiſhes as the water evaporates. When it is entirely evaporated, which is not ſoon, the alum which had ſwelled much during this operation, remains dry and friable; it is then called *Calcined Alum.* After this evaporation, it may be again diſſolved in water, and cryſtallized as before.

Although the acid of alum appears, as its taſte and ſolubility indicate, to be leſs intimately combined with its baſis than the acid of ſelenites is, yet but a very ſmall quantity of it can be diſengaged by the ſtrongeſt fire. Mr. Geoffroy put ſome calcined alum into an earthen retort, and expoſed it to a moſt violent fire continued during ſix days and ſix nights; and from five pounds of alum thus treated he obtained only three ounces of vitriolic acid, although it is certain that this ſalt contains a much greater proportion of acid, as we ſhall ſoon ſee. The acid thus obtained by diſtillation from alum is called *Spirit of Alum*; and does not differ from pure vitriolic acid.

Alum may be eaſily decompoſed by ſeveral intermediate ſubſtances.

Firſt, as the acid of alum is certainly the vitriolic, all ſubſtances which have a greater affinity than earths to vitriolic acid, are capable of uniting with it, and of ſeparating from it its earthy baſis.

Alum, therefore, treated properly with any matter containing phlogiſton, may be decompoſed; its acid uniting with it, and forming artificial ſulphur. *See* SULPHUR.

It is by means of this artificial ſulphur, which is formed during the calcination of alum with any vegetable or animal matter, that the *pyrophorus of Homberg* is made, which has the property of burning merely by contact of air. *See* PYROPHORUS.

In the ſecond place, all ſaline alkalis are capable of decompoſing alum. This decompoſition may be made in the humid way. Thus if any alkali be added to a ſolution of alum, the liquor immediately becomes turbid and white, and a ſediment is formed, which is the earth of alum ſeparated from its acid by the intervention of alkaline ſalt. On the other ſide, the new ſalt formed by the union of the acid of alum with the alkali, may be cryſtallized by evaporating the liquor. If fixed vegetable alkali was employed for this precipitation, vitriolated tartar is formed: if mineral alkali was employed, Glauber's ſalt is formed. This decompoſition of alum is a very convenient method of preparing theſe two ſalts. Laſtly, if volatile alkali be employed for this precipitation of the earth of alum, vitriolic ammoniacal ſalt will be formed.

Calcareous earths, and even ſome metallic ſubſtances, are capable of decompoſing alum. The former are ſo, becauſe their affinity is greater than that of the argillaceous earth of alum with the vitriolic acid; and the latter, for inſtance iron and zinc, are ſo, becauſe of the ſlight adheſion of their phlogiſton.

It appears that Mr. Geoffroy was the firſt who diſcovered that iron could decompoſe alum; and this he did by boiling alum in an iron pot. This experiment of Mr. Geoffroy is found in the Memoirs of the Academy of Sciences.

What has been ſaid concerning theſe different decompoſitions of alum proves inconteſtably, that the acid of this ſalt is the pure vitriolic; and this truth has been known a conſiderable time; but till lately, the nature of the earthy baſis of alum was not preciſely and diſtinctly underſtood. For a long time it was conſidered by chemiſts as a calcareous earth: but accurate experiments have ſince ſhewn, that calcareous earths, united with vitriolic acid, formed ſelenites and not alum, which are entirely different; and that the earth of alum could not decompoſe ſal ammoniac, nor be converted into quicklime, nor had any of the diſtinguiſhing properties of calcareous earth. Theſe experiments have been made by Pott, Margraaf, and Baron. This laſt chemiſt, ſtruck with the differences betwixt earth of alum and calcareous earth, and with the reſemblance betwixt alum and moſt vitriolic ſalts with metallic baſes, has given a Memoir to the Academy of Sciences, in which he conjectures that this earth of alum is of metallic nature.

On the other ſide, there were experiments which proved that the earth of alum was contained in clays. Mr. Geoffroy and Mr. Hellot had ſaid, that, by digeſting clays with vitriolic acid, they had obtained ſalts of the nature of alum. Hellot, having employed a clay as an intermediate ſubſtance in the diſtillation of the ether of Frobenius, perceived that the vitriolic acid of this mixture had deprived the clay of all its argillaceous properties, by taking from it an earth, which being again ſeparated from this acid by an alkali, had all the properties of pure clay. *See Memoirs of the Academy for the year* 1739. Mr. Pott, who quotes in his Lithogeognoſia this experiment of Mr. Hellot, having ſatisfied himſelf with regard to the properties of the alum obtained by digeſting vitriolic acid upon clay, concluded that the earth of alum is of an argillaceous nature. *See Pott's Lithogeognoſia.* Mr. Gellert in his Metallurgic Chemiſtry, and eſpecially Mr. Margraaf, in three diſſertations upon alum, have mentioned the ſame experiments, and have drawn from them the ſame concluſions. Laſtly, Mr. Macquer, in a Memoir read at the Academy in 1762, *concerning clays and their fuſibility when joined to calcareous earth*, after having quoted the above citations, which are extracted from that memoir, places the affair beyond doubt, by adding his own experiments and obſervations to thoſe already made. "I add," ſays this chemiſt, "to all theſe teſtimonies, that having "made an accurate examination of the properties of the "earth of alum, ſeparated from every acid, I am convinced, "by all the proofs to which I have ſubmitted it, that it "has an entire and perfect reſemblance to the pureſt clay: "that is, to clay perfectly ſeparated from vitriolic acid and "all ſandy matter. I have obſerved, that earth of alum, "properly prepared, has all the argillaceous properties "attributed to it by the above-mentioned chemiſts, and "particularly a very binding quality. I have alſo obſerved, "that this earth is very difficultly dried, and that it ſtrongly "retains the laſt portions of moiſture. By drying, its "bulk is conſiderably diminiſhed, which occaſions it to be "much cracked. It receives a poliſh like all fat clays, when "rubbed with a ſmooth body. If it be expoſed ſuddenly to "fire before it be perfectly dried, it decrepitates ſtrongly, "and burſts with great noiſe, like clays. When it has "been gradually heated, and then expoſed to a violent fire, "I have obſerved that it has acquired a flinty hardneſs, and "that by this baking and hardening in the fire it has contracted to one half in all its dimenſions.

"Notwithſtanding this hardening, and great contraction "of its ſize by fire, it is remarkably refractory. It reſiſted "the greateſt violence of fire that I was able to expoſe it to "without ſhewing the leaſt tendency to melt. Having "mixed it with fritts of cryſtal-glaſs, and different fluxes,

" ſuch as fixed alkaline ſalts, nitre, borax, glaſs of lead, I " have found that theſe matters melted and vitrified, without " melting this earth; ſo that it has always communicated an " opacity to all the glaſſes reſulting from theſe mixtures.

" A very remarkable property of this earth, but which, " like the foregoing properties, is common to it with clays, " particularly when very pure, is, that though its color be " very white, yet this whiteneſs cannot be preſerved: for " when it is moiſt it greedily abſorbs all greaſy, and con- " ſequently coloring particles from contiguous bodies. " When expoſed to moderate fire, it begins to blacken; " then it becomes more or leſs white, according to the " nature of its coloring matter: but to whiten it thus, it " ought not to be entirely cloſed, but to have a free com- " munication with external air. Laſtly, If the fire be " encreaſed ſufficiently to harden well and bake this earth; " then in whatever manner, and with whatever attention it " may have been prepared, it never fails to reſume ſo much " more color as it is heated more intenſely. It takes all " ſorts of tints, yellowiſh, greeniſh, bluiſh, grey, brown, " and ſome I have ſeen become quite black. I have already " obſerved, that the ſame thing happens to natural clays, " when well deprived of ſand.

" This property denotes a very great diſpoſition in this " earth of uniting with the principle of inflammability, " and of retaining it ſtrongly when once united. This may " give occaſion to conjecture that the earths of metals, and " thoſe which are diſpoſed to metalliſation, are eſſentially " of argillaceous nature; and this idea adds a new probabi- " lity to the opinion of Mr. Baron, who, in a memoir " upon the earth of alum, conjectures that this earth is " of metallic nature, although not really reducible into " metal, at leaſt by any proceſſes hitherto aſcertained, and " ſufficiently known.

" However that be, it appears well aſcertained by the " chemical experiments quoted above, and by mine, that " earth of alum is a pure clay, free from all mixture of " vitreſcible earth; and that all natural clays are mixtures " of greater or leſs quantities of this pure argillaceous earth, " which is capable of combining with vitriolic acid, and " of forming with it alum; and of another ſubſtance of " different nature, which in its natural ſtate cannot com- " bine with vitriolic acid, and which Mr. Margraaf con- " ſiders as a true ſand, as indeed it has all the marks of " that kind of earth.

" From all this it may be inferred, that in all natural
" clays there is only this portion capable of forming alum
" with a vitriolic acid, which is a true argillaceous earth;
" and that the other portion is of a nature entirely different."
See CLAY.

Alum is capable of decompoſing nitre and common ſalt, in conſequence of the vitriolic acid it contains. The nitrous and marine acids may even be obtained more pure by means of alum than of any other ſubſtance.

All the alum which is in commerce is extracted by different operations from ſeveral pyritous, earthy, or ſtony matters, containing the vitriolic acid and the earth proper for forming this ſalt.

The pyrites or pyritous matters from which alum is extracted, ought to have effloreſced in open air, or to have been calcined in the fire, to allow the vitriolic acid of the ſulphur which they contain to diſengage itſelf. This acid meeting in the pyrites itſelf the argillaceous earth proper to form alum, does in fact there combine with it, and form that ſalt; which is afterwards extracted by lixiviation, evaporation, and cryſtallization, as is practiſed for all ſalts. Much of theſe pyrites or pyritous ſtones furniſhing alum are found in Sweden, England, Germany, and France, and they are worked according to the above general proceſſes. But to have a clear idea of what paſſes in theſe operations, it is neceſſary to know pyrites, and its nature; for which reaſon *ſee the word* PYRITES.

ROCK-ALUM. The alum which is extracted from pyritous mineral matters is ſeldom very pure, on account of the vitriolic metallic ſubſtances always contained in pyrites. I have examined many of theſe alums, and by the proofs made of them, I have found that they always contained a greater or leſs quantity of martial vitriol. This alum is in commerce called rock-alum, becauſe much of it is extracted from pyritous rocks or ſtones. It appears that the names *Ice-alum* and *Rock-alum* are ſynonimous and confounded in commerce, becauſe there is no difference in the price. Frequently theſe alums, which are in great maſſes, like ſtones, (which may alſo have contributed to the name Rock-alum) have a reddiſh tinge. Theſe are the impureſt, and contain moſt martial vitriol.

A large quantity of pure alum is extracted from the neighbourhood of Puzzoli, near Naples, at a place called *Solfatara*. *See* SULPHUR.

The Abbé Nollet, who viſited this place, and examined the works eſtabliſhed there, ſays, in the Memoirs of the Academy, that the matter from which the alum is extracted, is an earth ſimilar in its conſiſtence and color to the marle found in the ſame plain. I have examined this earth, and have found that it has the appearance, and nearly the conſiſtence of white marle: but it differs eſſentially from marle in not effervefcing with nitrous acid.

Caldrons of lead, two feet and a half in diameter, and as much in depth, are filled with this earth or ſtone to three quarters of their contents. Theſe caldrons are ſunk ſo as to be almoſt on a level with the ground under a great ſhed, at about the diſtance of four hundred paces from the ſulphur furnaces. Water is thrown into each caldron, till it riſes three or four inches above the bottom. The natural heat of the ground of this place is ſufficient to heat the matter, as it makes Mr. Reaumur's Thermometer riſe thirty-ſeven degrees and a half above the freezing point: and thus fuel is ſaved. By means of this digeſtion, ſays the Abbé Nollet, the ſaline part is diſengaged from the earth, and riſes to the ſurface, whence large cryſtals are obtained.

The alum in this ſtate is mixed with much impurities. It is carried to a building at the entry into the Solfatara, and it is diſſolved with hot water in a great ſtone veſſel ſhaped like a funnel. The alum is there cryſtallized again by the heat only of the ground, and becomes purer.

PLUME-ALUM. This name is given to two very different ſubſtances. One is a matter truly ſaline, which taſtes and diſſolves in water like alum, and cryſtallizes in form of feathers. This kind of alum, which is native, is found cryſtallized in grottos where aluminous mineral waters paſs. Mr. Tournefort obſerved it in his voyage into the Levant. It is rare, and not found in commerce. The other matter to which the name of plume-alum has been very improperly given, is nothing elſe than a *friable amianthus* or *aſbeſtus*. (*a*)

(*a*) The alum, which is found native with a lanuginous or plumoſe appearance, is probably formed by the decompoſition of pyrites, or ſome compound containing ſulphur and clay. By the diſſipation of the phlogiſton of the ſulphur, the vitriolic acid is diſengaged, and unites with the argillaceous earth, forming alum.

The name of *Plume-alum* is alſo given by Baſil Valentine, and other alchemical authors, to a compound formed of arſenic united with vitriolic acid.

ROMAN ALUM. In the territory of Civita Vecchia, about fourteen leagues from Rome, is found a hard ſtone whence a great deal of very fine and pure alum is extracted. The place where this ſtone is found and manufactured, is called *Aluminera della Tolfa.* This ſtone, which is neither pyritous nor calcareous, is manufactured by calcining it, as limeſtone is, for twelve or fourteen hours, after having broken it in pieces. This ſtone thus calcined is laid in ſeveral heaps upon places ſurrounded by ditches filled with water. It is ſprinkled with this water three or four times each day for forty days, or till the calcined ſtone enters into a kind of effervesſcence, and is covered with a reddiſh efflorescence. Then the ſtones are boiled with water in caldrons to diſſolve all the alum which is formed, and the water is then evaporated to the point of cryſtallization. This water is made to flow quite hot into oaken veſſels, where, by cooling, a great quantity of irregular cryſtals are formed of a pale reddiſh tinge. In this ſtate the Roman alum is ſold. It is not in large maſſes like rock-alum, but in lumps of the ſize of almonds, nuts, or eggs. This alum is alſo mixed with much reddiſh duſt. I have carefully examined the purity of Roman alum, and have found it to exceed much the purity of rock-alum. It contains no metallic or vitriolic matters; and is therefore preferred for certain dyes, the beauty of which is hurt by the ſmalleſt quantity of martial vitriol. Its price alſo is greater than that of rock-alum. *(b)*

Alum is very uſeful in ſeveral arts, and chiefly in dying, to which it is eſſentially neceſſary, as it heightens the intenſity and luſtre of moſt colors. It is even abſolutely neceſſary to give ſolidity to all thoſe colors which reſide in gummy ſubſtances. Without alum, theſe dyes would be only confuſed ſtains, which might be waſhed out by water. *See* DYING.

(b) A remarkable circumſtance attends the cryſtallization of alum, namely, that good cryſtals of this ſalt cannot be formed, unleſs an alkaline lixivium or urine be added to the lixivium of alum when ſet to cryſtallize. Chemiſts ſuppoſed that by adding theſe alkaline matters, ſome metallic or impure earthy ſubſtance which prevented the cryſtallization was precipitated; but Mr. Margraaf found by experiments that he could not form good cryſtals by combining vitriolic acid with earth of alum, with calcined alum, or with clay, unleſs he added a lixivium of fixed or volatile alkali, or urine. He ſuppoſes that theſe alkaline lixiviums produce their effect either by engaging a ſuperabundant acid, or ſome greaſy matter which prevents the cryſtallization.

Alum is an aſtringent drug of powerful efficacy; conſequently it is proper for diſeaſes where the principal indications are to fortify and conſtringe, as for immoderate menſtrual and lochial diſcharges, loſſes of blood, fluor albus, diarrheas, hæmorrhages, vomitings of blood, and even ſome kinds of hemoptoes. But it is neceſſary to obſerve on the ſubject of this remedy, and even of all other aſtringents, that they ought only to be preſcribed by intelligent phyſicians, who can diſtinguiſh whether or not theſe diſeaſes proceed from or are accompanied with inflammation, or too great plenitude: for in theſe caſes, aſtringents, ſo far from being uſeful, muſt be pernicious, and increaſe the cauſe of the evil. Alum is improper in theſe maladies, but when it is evident that they proceed from a mere relaxation, or from a rupture of the veſſels: in theſe caſes it has excellent effects.

As alum is one of the ſtrongeſt aſtringents, and as it is even ſomewhat cauſtic, ſeveral intelligent phyſicians, as Mr. Cartheuſer, and Mr. Baron, in his Notes on Lemery's Chemiſtry, prohibit the internal uſe of it; notwithſtanding which it is every day uſed ſucceſsfully in the abovementioned caſes. However, it is prudent to adminiſter alum at firſt in very ſmall doſes only, as two or three grains, except in very urgent caſes, where it may be given to ten or twelve grains. It may be given either alone, or joined with other aſtringent or blunting medicines, according to the particular indications.

Alum being ſuſceptible of decompoſition by all alkaline and calcareous matters, it muſt not be mixed with theſe ſubſtances, when intended to act as an aſtringent. Alum is often uſed externally; it conſtringes and fortifies conſiderably the parts to which it is applied: conſequently it is an efficacious repellent, and is uſeful in collyriums and in aſtringent gargariſms. When calcined, its powder is ſprinkled on ſoft and fungous fleſh, which prevents the cicatriſation of ulcers. It abſorbs their moiſture, dries and conſumes them.

ALUMINOUS. Whatever contains alum, or partakes of the nature of that ſalt, is called aluminous.

ALKANET. *(c)*

(c) ALKANET. The cortical part of the root of this plant, which is a kind of Buglofs, contains a red colorific matter, capable of being extracted by oils, by wax, and by ſpirit of wine. Wax thus colored, applied to warm marble, leaves a red ſtain.

ALMONDS. (d)

ALOES. (e)

ALTHEA. (f)

AMALGAM. This word is applied to the allays of metallic matters with mercury.

Mercury being a metallic ſubſtance cannot contract any union with earthy matters, not even with the earths of metals when deprived of their phlogiſton, and their metallic form. But it is capable of being allayed more or leſs eaſily with almoſt all metallic ſubſtances.

As mercury is habitually fluid; as it ought to be conſidered as metal perpetually in fuſion; and as it is ſufficient for moſt combinations that one of the two bodies that are to be combined be fluid; it follows that without the help of heat, mercury may be amalgamated with many metallic ſubſtances. There are two methods generally uſed of making amalgamas. The firſt is merely by trituration, and without heat. The ſecond is by fuſing the metal which is to be amalgamated, and by adding to it, when fuſed, the intended quantity of mercury.

Metals, by their union with mercury, become friable and capable of being pulverized, when the mercury is only in ſmall quantity. But when the mercury is added in larger quantities, the metals are by it reduced to kinds of paſte, which have no ductility nor tenacity.

(d) Almonds, *ſweet* and *bitter*, contain an expreſſible oil and farinaceous ſubſtance. The bitter part of bitter almonds is not expreſſed with the oil, but may be diſſolved by digeſtion in aqueous and in ſpirituous liquors, and with theſe may be diſtilled. Waters diſtilled from bitter almonds, or from moſt other bitter vegetables, fruits, and flowers, which have a ſimilar flavor to them, are poiſonous to birds, to ſome animals, and have ſometimes been ſo to men.

(e) Aloes is an inſpiſſated bitter juice extracted from the leaves of a plant of the ſame name. It is partly gummy, and partly reſinous; and the gum and reſin are ſo well mixed together, that moſt of the juice is ſoluble either in aqueous or ſpirituous menſtruums.

(f) Althea, or *Marſh-mallow*. Two ounces of the root of althea yielded, with water, ten drams and fifty grains of mucilaginous extract; and afterwards, with ſpirit, forty-one grains of reſin. An equal quantity of that root treated firſt with ſpirit gave ſix drams of a reſinous extract, a conſiderable part of the mucilage diſſolving in that menſtruum along with the reſin. The remainder boiled in water gave five drams and forty-eight grains of pure mucilage. The indiſſoluble earthy part was one-fourth part of the root, and one half of the leaves of althea. *Neuman.*

Of all metals, gold has the greateſt affinity to mercury, and unites with it moſt eaſily. For this purpoſe nothing more is requiſite than that the mercury ſhould be ſlightly rubbed on a piece of gold, or that it remain ſome time in a golden veſſel. The ſurface of the gold which has touched the mercury becomes white as ſilver; and if the gold is thin, its conſiſtence is deſtroyed in that place, ſo that it very eaſily breaks. But the amalgamation of mercury with gold is conſiderably accelerated by dividing the gold into very ſmall parts or very thin plates. All metals ought to be ſo divided, when they are to be amalgamated by trituration without fuſion or heat. *(g)*

Silver may be amalgamated nearly in the ſame manner as gold. Mr. Gellert has obſerved a ſingular and remarkable phenomenon in this amalgam, which is, that its ſpecific gravity is not only greater than the intermediate ſpecific gravity of the mercury and of the ſilver, but that it is even greater than the ſpecific gravity of mercury, although ſilver be greatly lighter. *See* SILVER *and* MERCURY.

Mr. Gellert aſcertained this fact, not only by obſerving that the amalgam of ſilver ſinks to the bottom of a veſſel containing mercury, but alſo by the exacteſt hydroſtatical experiments. *See his Metallurgic Chemiſtry, Tom. I.*

The amalgams of gold and ſilver, and particularly the firſt, are much uſed for the ſeparation of theſe two metals from their ores, or rather from the earthy and ſtony matters with which they are mixed. *See* ORES *of* GOLD, *and of* SILVER. Theſe amalgams are alſo uſed for ſome kinds of *gilding* and *ſilvering*. *See theſe two words.* The amalgam of ſilver is alſo employed for the *Arbor Dianæ*. *See* ARBOR DIANÆ.

(g) As an amalgam of gold is much uſed for gilding metals, we ſhall mention that the plates or grains of that metal may be more eaſily and perfectly amalgamated by applying them red-hot to the mercury, which ought alſo to be previouſly heated till it begins to ſmoke, and by ſtirring the mixture with an iron rod till the gold diſappears, which will be very ſoon. When the quantity of mercury is ſo large that the maſs is fluid when cold, the ſuperfluous part of it may be ſeparated by paſſing it through ſoft leather: this contains a very ſmall portion of gold. The remaining amalgam has the conſiſtence of butter, and contains about one part of mercury to two parts of gold, but is nearly as white as ſilver.

The amalgamation of all metals with mercury is much facilitated by heat. But the amalgamation of thoſe metals which unite difficultly with mercury cannot be effected without heat. For this purpoſe, the mercury ought to be heated till it begins to riſe in vapors; and the metals of difficult fuſion, which we ſuppoſe to have been previouſly divided into ſmall parts, ought to be made red by fire, and quickly triturated with the hot mercury. As to the metals which melt before they become red, ſuch as tin and lead, it is ſufficient to melt them, and to throw the mercury upon them, ſtirring a little the mixture: and thus the amalgam is made in an inſtant.

It would be very imprudent to melt metals which require a great heat for their fuſion, as copper, for inſtance, and to add mercury to this melted metal, with an intention to make an amalgam; becauſe not only the greateſt part of the mercury would be diſſipated in vapors before it could be united to the metal, but alſo becauſe there would be great danger of exploſion from the mercury, which being a rarefiable and volatile body, is capable, like all ſuch bodies, of producing this effect, when ſuddenly expoſed to too great heat.

Mercury amalgamates difficultly with copper, more difficultly with regulus of antimony, not at all with iron *(h)*, nor, as Mr. Gellert ſays, with cobalt. But with all the other metals and ſemi-metals it may be eaſily amalgamated.

The amalgam of mercury with tin is much uſed for covering one of the ſurfaces of mirrors, and thus rendering them capable of repreſenting images more ſenſibly and perfectly. *See* TINNING *of* LOOKING-GLASSES. This amalgam is alſo uſed for the preparation of mercury-balls, intended to purify water. *See* BALLS (MERCURY).

Biſmuth when amalgamated with mercury has the ſingular property of ſo attenuating lead added to this amalgam, that a great part of this metal may be paſſed through leather along with the mercury. Mr. Cramer adviſes, in order to

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(h) Dr. Lewis obſerves, that mercury adheres to, and coats the ends of iron peſtles uſed for the trituration of amalgams, and that a plate of tough iron may be rendered brittle by keeping it immerſed in mercury during ſome days. Hence he infers, that mercury is not incapable of acting upon iron. But as mercury has been found not to riſe ſo high in barometrical tubes made of iron, as in thoſe made of glaſs, have we not reaſon to believe that theſe metallic ſubſtances poſſeſs a power of repelling each other? *See the Hiſt. de l'Acad. Royale des Sciences, pour* 1716.

make this experiment ſucceed, to melt the lead firſt with the biſmuth, and to this mixture to add the mercury. He further ſays, that if this amalgam be digeſted ſeveral days, the biſmuth will be ſeparated, and will leave the attenuated lead united to the mercury.

Regulus of antimony can, as was ſaid above, very difficultly be united with mercury. Mr. Gellert ſays, that to make this amalgam ſucceed, the regulus ought to be put into hot mercury, and the whole covered with water. But that when the regulus of antimony has been prepared by means of iron, or an alkaline earth, this amalgam may be made much better, ſo that the regulus ſhall not ſeparate, after ſtanding ſome time, from the mercury, as it uſually does.

The affinities of metallic ſubſtances with mercury are placed, according to Mr. Geoffroy, in the following order: gold, ſilver, lead, copper, zinc, regulus of antimony.

According to Mr. Gellert's Table, they are, gold, ſilver, biſmuth, zinc, tin, lead, copper, regulus of antimony.

As the amalgams of mercury are true allays of metallic ſubſtances, all the general properties of allays are applicable to them. *See* ALLAY.

AMBER. *See* BITUMEN.

AMBERGRISE. Is a ſubſtance of a grey color, which moſt chemiſts and naturaliſts have claſſed amongſt bitumens, rather from its properties and the principles it yields by diſtillation, than from any certain knowledge of its origin. For it does not appear that any truly foſſil ambergriſe is known, and that any is found in commerce, but what is procured from the Indian ſea, upon which it floats in the neighbourhood of the Molucca iſlands.

Mr. Cartheuſer thinks that ambergriſe ought certainly to be conſidered as a bitumen; and he is determined to this opinion from the analyſes made of it by ſeveral chemiſts, and particularly by Neuman. From which analyſes it appears, that the ſame principles were obtained from ambergriſe as from amber, that is to ſay, phlegm, a volatile acid, partly fluid and partly ſolid, oil, and a little coaly matter. *(i)*

Beſides,

(i) The origin of ambergriſe is very uncertain. Many naturaliſts have conſidered it as a foſſil bitumen; ſome as an excrement of whales; and from a late diſſection of a crocodile, in the teſticles of which a French ſurgeon perceived a ſmell reſembling that of ambergriſe, it has been ſuppoſed to be the ſeminal fluid of

Beſides, ambergriſe is nearly as difficultly ſoluble as amber and other bitumens in different menſtruums: but it differs from amber in this, that it is much ſofter, is not ſmooth, nor is capable of taking a poliſh. Further, it is not tranſparent, and it is capable of fuſion. The heat of the hands alone is ſufficient to ſoften it like wax. It alſo leaves much leſs coaly reſiduum than amber, after diſtillation. All theſe properties denote that ambergriſe is much more oily than amber.

The agreeable ſmell of ambergriſe renders it uſeful in perfumes. Muſk however is always joined with it, or ſubſtituted for it; not becauſe muſk is cheaper, for it alſo is very dear, but becauſe its ſmell is greatly ſtronger, and goes farther in the preparation of perfumes.

Ambergriſe is alſo uſeful in medicine. It has the ſame general virtues as all the odoriferous ſubſtances, from the ſpiritus rector or highly attenuated and volatile oil, which is the principle of their ſmell. It enters into the compoſition of many cordial, ſudorific, and alexiterial waters. It is alſo ſaid to be a venereal ſtimulant. But its chief virtue conſiſts in its antiſpaſmodic and ſedative qualities ſimilar to thoſe of muſk and caſtor, and in its power of relieving certain hyſterical, convulſive, and other nervous affections. It may be taken inwardly from half a grain to ten or twelve grains or more. For, as to doſes, there can be no fixed rules about remedies and diſeaſes of theſe kinds.

AMMONIAC (SALT). All neutral ſalts compoſed of any acid ſaturated with volatile alkali, may be called ammoniac ſalts. But the name *Sal-ammoniac* is more eſpecially appropriated to the neutral ſalt reſulting from the union of the acid of common ſalt with volatile alkali. All the other ammoniacal ſalts are ſpecified by particular epithets, as *vitriolic ammoniacal ſalt*, *nitrous ammoniacal ſalt*, and *vegetable ammoniacal ſalt*. We ſhall ſpeak ſucceſſively of theſe ſeveral ſalts.

All ammoniacal ſalts have the general properties of neutral ſalts, compoſed of acids and alkalis. But they differ from

of that animal condenſed by heat. M. Francheville, in a diſſertation on ambergriſe, thinks that the moſt probable opinion which has been ſuggeſted concerning the origin of ambergriſe, is, that it is a compound of honey and wax, which has been depoſited by bees among the rocks that ſkirt the iſlands in the Eaſtern Seas, and is afterwards dried by the heat of the ſun, and diſengaged from the rocks by the wind.

the neutral ſalts whoſe baſes are fixed alkalis, by their more pungent taſte, which proceeds from the leſs adheſion of acids in general with volatile alkali than with fixed alkali; in the ſecond place, by their leſs fixity, all the ammoniacal ſalts being ſemi-volatile, that is, capable of ſubliming to a certain height, when expoſed to a ſtrong enough fire. This property proceeds from the volatility of their alkaline baſes. Laſtly, ammoniacal ſalts are ſuſceptible of decompoſition by many ſubſtances not capable of producing the ſame effect on neutral ſalts whoſe baſes are fixed alkali; as we ſhall ſee by a more particular examination of the properties of theſe ſalts.

The moſt generally known and uſed ammoniacal ſalt is that which contains the acid of common ſalt. This ſalt, when very pure, is very white, ſemitranſparent, capable of forming feather-like cryſtals, or of ſubliming in cloſe veſſels into a compact ſtriated maſs.

This ſalt is eaſily ſoluble in water. It deliquiates into a liquor when expoſed ſome time to a moiſt air. It is one of the ſalts which produce the moſt cold during their ſolution in water. This generation of cold is ſo great as to ſink the thermometer eighteen or twenty degrees, and even more, according to the temperature of the atmoſphere. It appears that the hotter this temperature is, the greater cold is generated, which proceeds from the greater and quicker ſolubility of this ſalt in warm than in cold water. Mr. Gellert [*Metallurgic Chemiſtry, tom.* I.] ſays, that if any gum or reſin be boiled in water impregnated with ſal-ammoniac, theſe ſubſtances will be diſſolved in it. It is not ſurprizing that gums ſhould be thus diſſolved, conſidering that water is their proper menſtruum. But as pure water does not at all attack reſins, their ſolution in Mr. Gellert's experiment muſt proceed from the ſal-ammoniac.

Sal-ammoniac cannot be decompoſed merely by the action of fire in cloſe veſſels; becauſe it then entirely ſublimes, as we have already obſerved. To decompoſe it, therefore, we muſt employ ſome intermediate ſubſtance capable of diſengaging either its acid or its alkali.

The acids having, from their ſeveral affinities, the ſame relations to volatile alkali as they have to fixed alkali, (*See* ALKALI VOLATILE) it follows that ſal-ammoniac ought to furniſh the ſame phenomena of decompoſition by the vitriolic and nitrous acids, as common ſalt does. Theſe two acids then are capable of decompoſing ſal-ammoniac, by ſeparating its acid, which paſſes alone in diſtillation, and by uniting themſelves with the volatile alkali, with which the firſt forms a vitriolic ammoniacal ſalt, and the ſecond a nitrous ammoniacal ſalt.

It is proper to obſerve upon the decompoſition of ſal-ammoniac by nitrous acid, 1. That the marine acid does not riſe ſingly in diſtillation, but is always accompanied with a good deal of nitrous acid, which riſes in conſequence of its volatility, and, together with the marine acid diſengaged from the ſal-ammoniac, forms an *aqua regia.* 2. That in this operation great management, ſlowneſs, and precautions are neceſſary, particularly if ſmoking ſpirit of nitre be employed; becauſe the vapors which paſs are more expanſible, and leſs condenſible than the pure vapors of the nitrous or of the marine acids, which difference undoubtedly proceeds from the reaction of theſe two acids upon each other. 3. That it is very neceſſary to attend carefully to the fire towards the end of the diſtillation, and when the matter remaining in the retort begins to be dry; becauſe it is a nitrous ammoniacal ſalt, which has the property of detonating alone, and with little heat. Prudence therefore requires that the diſtillation be not puſhed to perfect dryneſs. There is ſcarcely any operation in chemiſtry ſo liable to an exploſion as this is. *See* AMMONIAC (NITROUS SALT).

Sal-ammoniac is alſo capable of decompoſition by many ſubſtances, which, by uniting with its acid, ſet at liberty its volatile alkali.

Theſe ſubſtances are calcareous earths, quicklime, fixed alkalis, and metallic matters. The moſt eſſential phenomena which this ſalt exhibits, when treated by theſe different matters, are the following:

If powdered ſal-ammoniac be mixed with twice its weight of any calcareous earth, of chalk for example, alſo powdered, and the mixture be diſtilled with a proper apparatus, (*See* DISTILLATION) a large quantity of volatile alkali will paſs into the receiver, in a concrete form, very white and very beautiful, lining all the inſide of the receiver; and when the operation is over, we ſhall find in the retort a maſs containing all the acid of the ſal-ammoniac, engaged and retained in the calcareous earth: if conſequently this caput mortuum be lixiviated, in order to diſſolve all its ſaline part, we ſhall find that this lixivium is impregnated with much marine ſalt with earthy baſis. *See for the properties of this ſalt* ACID (MARINE), *and* SALT (MARINE) *with* EARTHY BASIS.

In this operation a true decompoſition happens of the ſal-ammoniac by the intervention of the calcareous earth. Mr. Duhamel ſeems to have been the firſt who diſcovered and publiſhed this decompoſition. He has obſerved, that the volatile alkali of the ſal-ammoniac, when it diſengages itſelf in this operation, carries off with it a part of the calcareous earth. We ſhall ſoon ſee that it alſo carries off part of other ſubſtances employed to diſengage it.

Mr. Beaumé, who has ſince repeated this experiment with his uſual accuracy, and in great quantities, has obſerved, that a quantity of volatile alkali may be obtained by this diſtillation equal in weight to the ſal-ammoniac employed, although it be certain, that there is nearly as much marine acid as volatile alkali contained in ſal-ammoniac. *(k)*

This ſalt treated with quicklime is ſtill more eaſily decompoſed than with uncalcined calcareous earth. To make this decompoſition, and to obtain the volatile alkali, powdered ſal ammoniac muſt be quickly mixed with twice its weight of quicklime, ſlaked by expoſure to air, and the mixture muſt be quickly put into a great ſtone-ware retort, to which a receiver muſt be immediately luted. *See* DISTILLATION. The action of the quicklime upon the ſal-ammoniac is ſo quick, that a good deal of volatile alkali is diſengaged as

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(k) Mr. Duhamel and other authors have attributed this great encreaſe of weight gained by volatile alkali, during its ſeparation from the marine acid in the decompoſition of ſal ammoniac, by intervention of chalk, or other mild calcareous earth, or mild fixed alkali, to part of the ſubſtance of the earth, or fixed alkali, being carried along with the volatile alkali. But the ſubſtance which volatile alkali does receive from theſe intermediate matters is not, as theſe authors have ſuppoſed, earthy, or alkaline, but is the gas or fixable air which is ſeparated from them, when they combine with the acid of the ſal ammoniac. In this operation, therefore, we have an inſtance of what our author calls *double affinity*; (*See* AFFINITY) the acid of the ſal ammoniac combining with the earthy part of the chalk, or with the ſaline part of the mild alkali; and the volatile alkali of the ſal ammoniac combining at the ſame time with the gas of the chalk, or of the mild alkali. That this addition of gas to the volatile alkali is ſufficient to render its weight equal to that of the ſal ammoniac employed, appears from Mr. Cavendiſh's experiments, which ſhew, that more than the half of the weight of mild volatile alkali is gas. *See* GAS, *and* ALKALI (VOLATILE).

ſoon as the two matters are mixed together, which obliges the operator to take care not to expoſe himſelf to breathe the vapors. The heat muſt be alſo attended to in this diſtillation, particularly at the beginning; becauſe then it is performed almoſt without fire.

It is very remarkable that volatile alkali, prepared by intervention of quicklime, never is, nor can be obtained in a concrete form, by any method. It is always liquid, and is called *volatile ſpirit of ſal-ammoniac.* It is evident that it is by means of the water contained in a large quantity in the ſlaked lime, and in which the volatile alkali is diſſolved, that it thus appears in a liquid ſtate; but it is certain that this ſaline matter ſo ſtrongly adheres to this water, that it cannot be ſeparated without ſome intermediate ſubſtance; and that, on the other ſide, this ſame water is ſo neceſſary to its ſeparation from the marine acid by the intervention of the lime, that Mr. Duhamel could not obtain volatile alkali by trying to decompoſe ſal ammoniac with quicklime, in the ſtate it is in when newly calcined, and ſtill hot from the kiln, and conſequently perfectly dry. *(l)*

This volatile alkali, although it be diffuſed in much water, is ſtill more active and more penetrating than that which is obtained by the intervention of other ſubſtances in a dry and concrete ſtate. Mr. Beaumé has obſerved, that the volatile ſpirit of ſal-ammoniac made with quicklime, when poured into a ſolution of any ſalt with earthy baſis, does not produce the ſame effects as the ſame alkali of ſal-ammoniac which has been diſengaged by calcareous earths or fixed alkalis, and which may always be procured in a concrete ſtate; as this latter volatile alkali eaſily decompoſes theſe ſalts with earthy baſes, and occaſions a copious white precipitate to fall from their ſolutions, while the

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(l) The volatile alkali obtained by this proceſs is cauſtic or uncombined with gas, and is therefore, as we have obſerved under the article VOLATILE ALKALI, always in a liquid ſtate. This liquid volatile alkali may alſo be obtained by employing cauſtic fixed alkali inſtead of the quicklime. From Mr. Duhamel's experiment mentioned in the text, by which he found that volatile alkali could not be obtained in this proceſs, unleſs water was combined with the quicklime, it appears probable, that this operation alſo is an inſtance of double affinity, and differing only from the former operation in this reſpect; that in this proceſs the volatile alkali receives water, and in the former it receives gas, from the calcareous earth. *See the laſt Note.*

former

former does not appear to produce any effect, but only occaſions a very light whitiſh cloud. *(m)*

Theſe differences prove that a ſingular alteration is produced upon volatile alkali by quicklime; and this alteration is probably cauſed by the quicklime depriving it of part of its inflammable principle by help of which it ſeems cryſtallizable, and conſequently by a partial decompoſition of it. Another phenomenon, no leſs important, ſupports this opinion; which is, that if volatile ſpirit of ſal-ammoniac be frequently diſtilled from new quicklime each time, we may eaſily perceive that there is a conſiderable quantity of it entirely decompoſed by each diſtillation; and that, on the other ſide, if, as Mr. Duhamel did, we lixiviate quicklime in a large quantity of water, till it makes no longer cream of lime, nor has the properties of quicklime; and if the lime thus decalcined, and reduced to the ſtate of mere calcareous earth, be employed for the decompoſition of ſal-ammoniac, we ſhall then obtain a concrete volatile alkali, as if a calcareous earth had been uſed, which had never been calcined. *See* QUICKLIME. *(n)*

When ſal ammoniac is decompoſed by the intervention of quicklime, a ſaline earthy matter is found in the retort: that is, a part of the quicklime above what was neceſſary for the decompoſition, and another part ſaturated with the acid of ſal ammoniac, and forming a ſort of ſea-ſalt with earthy baſis, which ſeems to be ſimilar to that ſalt formed by uniting marine acid with an uncalcined calcareous earth, but which ought to differ from it in many reſpects, and particularly by a ſtronger adheſion of the acid to the quicklime. *(o)* This ſalt, when dry, is called improperly *fixed ſal*

(m) Cauſtic or uncombined volatile alkali does not precipitate calcareous earths from acids; becauſe its power of combination with acids does not ſeem to be ſtronger than that of thoſe earths. But mild volatile alkali acts upon ſalts with baſes of calcareous earth, by what our author calls double affinity; that is, its alkaline part combines with the acid of thoſe ſalts, while its gas combines with the calcareous earth.

(n) Mr. Duhamel evidently reduced his quicklime to mild calcareous earth, that is, combined it with gas; we need not, therefore, wonder that the volatile alkali which he obtained was alſo mild, or combined with that gas.

(o) The ſalt formed by decompoſing ſal ammoniac with quicklime is preciſely the ſame as the ſalt formed by uniting marine acid with uncalcined calcareous earth: for the acid, uniting with uncal-

ſal ammoniac, and when deliquiated into a liquor, it is called *oil of lime*, or *liquid ſhell.*

Fixed alkali, either vegetable or mineral, eaſily decompoſes ſal ammoniac, and ſeparates from it by diſtillation the volatile alkali in a concrete ſtate, if there be little or no water in theſe matters: but if theſe matters contain water, or if water be deſignedly added, the alkali, which is more volatile than the water, paſſes firſt, partly in a concrete ſtate, then the water which riſes diſſolves it wholly or partly, according to the quantity of water, and it is thus reduced to a liquid ſtate. Mr. Duhamel obſerves, that in this diſtillation alſo the volatile alkali carries off with it a portion of the fixed alkali which is employed to diſengage it. *(p)*

The ſalt remaining in the retort after this diſtillation, is common ſalt, entirely ſimilar to ordinary ſea-ſalt, if the fixed alkali employed was the mineral alkali; and ſimilar to regenerated ſea-ſalt, or ſalt of Sylvius, if the vegetable fixed alkali was employed. *See* SALT (COMMON).

Moſt metallic ſubſtances alſo act upon ſal ammoniac, and are capable of decompoſing it.

Silver, copper, iron, tin, lead, and mercury, well mixed with this ſalt, and diſtilled together, diſengage its volatile alkali. The ſemimetals alſo produce the ſame effect. After the diſtillation is finiſhed, the metal is found combined with the acid of ſal ammoniac. This ſilver becomes *luna cornea*, and lead becomes *plumbum corneum.* In this manner Mr. Margraaf prepared his *plumbum corneum* which he employed in his operation for phoſphorus. *See* PLUMBUM CORNEUM; *and* PHOSPHORUS.

A remarkable thing occurs in this decompoſition of ſal ammoniac by lead, for which Mr. Margraaf requires a calx of lead, ſuch as minium, rather than lead itſelf, for the conveniency of the mixture; which is, that the volatile alkali which paſſes over in the diſtillation, although very ſtrong and much dephlegmated, is always in a liquid or fluor ſtate, which ſhews, that upon this occaſion, as in many others, metallic calces produce the ſame effect as quicklime.

As to mercury, it very certainly decompoſes ſal ammoniac, and ſeparates its volatile alkali. But if more ſal ammoniac was added than the mercury can decompoſe, this undecompoſed

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uncalcined calcareous earth, deprives it of its gas, and reduces it to the ſame ſtate in which the calcined earth, or quicklime is.

(p) See the note *(k)*

poſed part of the ſalt remains united with the combination of marine acid with mercury, and cannot by cryſtallization or ſublimation be ſeparated from thence. This fact has been aſcertained by Mr. Macquer; of which a detail is given in his Memoir upon the *Count de la Garaye's Tincture of Mercury*, printed in the collection of the Academy of Sciences in the year 1755.

Junker ſays, that regulus of antimony treated with ſal ammoniac diſengages the volatile alkali, and is converted into butter of antimony.

It is proper to obſerve on this occaſion of the decompoſition of ſal ammoniac by earthy and metallic ſubſtances, which unite with its acid and diſengage its volatile alkali, that as the volatile alkali thus diſengaged is capable of ſeparating in its turn all theſe ſame ſubſtances united to an acid, and even to the marine acid, there ſeems to be ſomething contradictory in the affinities of volatile alkali, and of earthy and metallic ſubſtances. Mr. Baron, in his Memoir upon Borax, and Mr. Macquer, in his Elements of Practical Chemiſtry, explain theſe effects in a plauſible manner, by the great difference of the fixity and volatility of theſe ſubſtances. It appears nevertheleſs that the ſubject is ſtill ſomewhat obſcure, and requires a more particular examination.

If, inſtead of mixing with ſal ammoniac ſufficient quantities of copper, iron, and even of moſt other metals, and with proper circumſtances for the decompoſition, theſe metals were employed in a ſmaller quantity, and that the heat was immediately raiſed ſufficiently intenſe for ſublimation, the ſal ammoniac would then be obtained ſublimed, or flowers of undecompoſed ſal ammoniac would be raiſed, containing ſome part of the metals. By this method ſome chemical preparations or medicines are made, which are named from the metals employed. Thus flowers of ſal ammoniac impregnated with copper are called *ens veneris*; thoſe impregnated with iron, are called *martial flowers of ſal ammoniac*, or *martial flowers*, or *ens martis*. *See theſe words.*

There are alſo other properties of ſal ammoniac which ought to be mentioned here.

This is one of thoſe ſalts which are ſoluble in ſpirit of wine. Mr. Macquer, in the above quoted memoir, has determined that thirty-two parts of well rectified ſpirit of wine are neceſſary for the ſolution of one part of ſal ammoniac.

Sal ammoniac acts conſiderably on mercury ſublimate corroſive. It diſſolves this ſalt and unites with it, without producing the decompoſition of either of the ſalts. From the union of theſe two ſalts, a mixed ſalt is produced which chemiſts have called *Salt Alembroth*. *See this word.*

Sal ammoniac is employed advantageouſly in many arts. It is particularly uſeful in the tinning of copper and iron. *See* TINNING. It is alſo employed in the fuſion of gold; becauſe it has been obſerved to exalt and heighten the color of that metal.

If ſal ammoniac be treated with nitre in a crucible, and with a red heat, the nitre is obſerved to deflagrate to a certain point. This phenomenon proceeds from the inflammable matter which enters into the compoſition of the volatile alkali, which is the baſis of the ſal ammoniac. It is alſo this ſame inflammable principle which produces the good effects of ſal ammoniac in the tinning of metals.

Sal ammoniac is found ready formed in vulcanos, or in their neighbourhood. It is called *native ſal ammoniac*; but it is in too ſmall quantity to furniſh the demands of artiſts. The ſal ammoniac ſold in commerce is made in great manufactories for this purpoſe.

The method of manufacturing ſal ammoniac was long unknown. Mr. Le Maire and Mr. Granger were the firſt who explained the proceſs, in very circumſtantial memoirs upon this ſubject communicated to the Academy of Sciences. An extract of theſe memoirs may be found in Mr. Macquer's Elements of Practical Chemiſtry; for which reaſon, we will only briefly mention, that in Egypt, where moſt of the ſal ammoniac is made which is in commerce, ſoot is employed for this purpoſe, which is produced by burning the dung of cows and camels, which are the ordinary fuels of that country. This ſoot is put into large glaſs veſſels arranged near each other in oblong furnaces. The fire is raiſed gradually, that all the volatile principles of the ſoot may be driven off; then the fire is encreaſed towards the end, by which the ſal ammoniac is ſublimed, the materials of which were contained in the ſoot; the glaſs veſſels are then broken to get out the loaves of ſal ammoniac, which are formed upon the upper interior parts of the glaſs veſſels. Theſe loaves or cakes, as they are found at the ſhops of druggiſts, weigh from three to five or ſix pounds. They are more or leſs blackened by a quantity of fuliginous or ſooty matter, which riſes with the ſal ammoniac in the ſublimation. *See* SOOT.

Sal ammoniac may be purified from this extraneous matter by the means commonly employed for the purification of ſalts, that is, by diſſolving in water, filtrating, cryſtallizing, and by ſubliming a ſecond time, if this ſhould be thought neceſſary: a ſal ammoniac is then obtained perfectly white and pure. Sal ammoniac may be made by combining marine acid to the point of ſaturation with volatile alkali, obtained from the diſtillation of animal or vegetable ſubſtances, and by filtrating, cryſtallizing, and ſubliming the ſaline matters thus combined. But this ſal ammoniac would coſt more than the price it is generally ſold for. Although the volatile alkali uſed for this proceſs, ſolid or liquid, be very impure and impregnated with much empyreumatic oil, from which it is difficult to purify it, yet the ſal ammoniac obtained from it by this method is very pure and good; becauſe the volatile alkali, when it combines with an acid, ſeparates itſelf from all the ſuperabundant oil with which it was at firſt combined: hence the volatile alkali obtained by decomſing ſal ammoniac is better diſengaged from all ſuperabundant oily matter than what is obtained by any other method. But we muſt obſerve, that the volatile alkali obtained from ſal ammoniac always carries off with it ſome of the ſubſtance employed for the decompoſition. This circumſtance muſt produce different effects in chemical experiments, to which attention ought to be given. *(q)*

AMMONIACAL SALT (VITRIOLIC). This is a netural ſalt compoſed of vitriolic acid ſaturated by volatile alkali.

This ſalt may be made by ſeveral different methods.

(q) To the above article we ſhall add; 1. Sal ammoniac requires four times its quantity of water to diſſolve in that liquid. 2. Its volatility is diminiſhed ſo much by repeated ſublimations, that it remains half fluid at the bottom of the ſubliming veſſel; and when ſal ammoniac was repeatedly ſublimed together with mercury corroſive ſublimate, and the reſiduum of each preceding operation mixed with the ſublimed ſalt, the whole matter became quite fixed in the fire, and would no longer riſe from the bottom of the glaſs. *Neuman.* 3. The degree of heat neceſſary to volatilize ſal ammoniac is a little below that of ignition, nearly the ſame with which lead is melted. 4. Pott ſays, that a ſmall quantity of ſal ammoniac may be produced by diſtilling ſea-ſalt with charcoal or with alum, or by diſtilling marine acid with Armenian bole. 5. The ſame author affirms, that the inflammability of ſulphur is deſtroyed by ſubliming it with twice its quantity of ſal ammoniac.

1. By combining vitriolic acid with diſengaged volatile alkali.

2. By decompoſing ſal ammoniac by vitriolic acid in Glauber's manner. If this latter method be uſed, a marine acid is obtained by diſtillation, ſtrong in proportion to the concentration of the vitriolic acid employed; and in the retort the vitriolic ammoniacal ſalt remains, which *Glauber* called his *ſecret ſal ammoniac.*

3. By decompoſing all vitriolic ſalts with earthy or metallic baſes, by means of volatile alkali. *See* ALKALI (VOLATILE).

This ſalt has the properties of ſal ammoniac, with the differences depending on their different acids. It is ſemi-volatile; it may be entirely ſublimed; it cannot be decompoſed in cloſe veſſels without ſome intermediate ſubſtance; it has a ſharp taſte; it eaſily diſſolves in water; and is ſuſceptible of cryſtallization. This ammoniacal ſalt is not uſed in arts or in medicine. Glauber attributes many wonderful properties to it, which it certainly does not, ſo eminently at leaſt as he pretends, poſſeſs.

AMMONIAC SALT (NITROUS). This ſalt is compoſed of nitrous acid ſaturated with volatile alkali. It is found in earths, or plaſters where nitrous acid is generated, when theſe earths have imbibed a ſufficient quantity of putrid animal or vegetable ſubſtances to furniſh volatile alkali to the nitrous acid, which is there generated.

Nitrous ammoniacal ſalt may be made, as the vitriolic, by three methods.

1. By combining to the point of ſaturation nitrous acid with volatile alkali.

2. By decompoſing ſal ammoniac by means of nitrous acid.

3. By decompoſing nitrous ſalts with earthy or metallic baſes, by means of volatile alkali. *See* ALKALI (VOLATILE).

Nitrous ammoniacal ſalt has a very pungent taſte; is ſoluble in water; capable of forming beautiful needle-like cryſtals, like thoſe of ordinary nitre.

This ſalt has the ſingular property of detonating alone, when expoſed to a certain degree of heat, and without the neceſſity of addition, as in ordinary nitre, of inflammable matter. It ſeems even to inflame with leſs heat than nitre mixed with inflammable matter does.

This property proceeds from the phlogiſton or inflammable matter which enters as a principle into the compoſition of the volatile alkaline baſis of this ſalt. This property alſo furniſhes a deciſive proof of the exiſtence of this inflammable matter in volatile alkali.

This inflammability of nitrous ammoniacal ſalt renders it incapable of ſublimation, like the other ammoniacal ſalts, as an exploſion would certainly happen in the operation. Chemiſts do not ſeem to have examined particularly the properties of this ſalt; neither is it uſed in arts or in medicine. If this curious ſalt were to be more particularly examined, the operator would need the greateſt circumſpection to avoid exploſions.

AMMONIACAL SALT (VEGETABLE). This name is given to all neutral ſalts formed by combinations of volatile alkali with vegetable acids. But theſe ſalts are hitherto little known, although they deſerve to be examined. The ſaline combination formed by volatile alkali and vinegar is called *Spirit of Mindererus*.

AMMONIACAL SALT (ANIMAL). As the fat of animals contains much acid (*See* FAT), an ammoniacal ſalt might be formed by combining this acid with volatile alkali, which might be properly called animal ammoniacal ſalt. But this combination has not yet been made, or examined.

Laſtly, the phoſphoric ſalt, or native ſalt of urine, belongs to the claſs of ammoniacal ſalts; and as its acid appears to be peculiarly animal, it would alſo be in this ſenſe a true animal ammoniacal ſalt. *See* SALT (FUSIBLE) *of* URINE.

AMMONIAC (FIXED). *(r)*

AMMONIAC (GUM). *(s)*

AMETHYST. *(t)*

AMIANTHUS. *(u)*

(r) FIXED AMMONIAC is a name given to the reſiduum formed by decompoſing ſal ammoniac with a calcareous earth. It is a ſalt compoſed of that earth and marine acid. *See* SALT (MARINE) *with* BASIS *of* CALCAREOUS EARTH.

(s) GUM AMMONIAC is a gum reſin, from an ounce of which ſix drams may be diſſolved by ſpirit of wine, or ſix drams two ſcruples and a half may be diſſolved by water. *Neuman.*

(t) AMETHYST. This is a violet-colored, frequently yellowiſh or reddiſh, pellucid gem, the ſeventh in degree of hardneſs from diamonds, fuſible by fire, which alſo deſtroys its color. It is found amongſt quartz, and is probably only a colored quartz cryſtal. This ſtone may be imitated by adding to a fritt of cryſtal-glaſs eight parts of magneſia and one part of zaffre.

(u) AMIANTHUS is the lighteſt and ſofteſt of all ſtones. It conſiſts of fibres parallel or interwove, ſo flexible, that cloth has

ANALYSIS. Chemiſts underſtand by the word analyſis, the decompoſition of a body, or the ſeparation of the principles and conſtituent parts of a compound ſubſtance.

Chemiſtry furniſhes ſeveral means for the decompoſition of bodies. Theſe means are all founded on the differences of the properties belonging to the different principles of which the body to be analyſed is compoſed. Thus, for example, if a body be compoſed of ſeveral principles, ſome of which have a great, and others a moderate degree of volatility; and, laſtly, others are fixed, its moſt volatile parts may be firſt ſeparated, by a graduated heat, in diſtilling veſſels, and then the parts which are next in volatility will paſs over in diſtillation; and laſtly, thoſe parts which are fixed, and capable of reſiſting the action of fire, will remain at the bottom of the veſſel. As this analyſis cannot be made but by means of fire, it is called the *Analyſis by fire*.

It is proper to obſerve, that this method of analyſing does not ſucceed equally well upon all bodies, and that it is very imperfect upon ſome bodies, which being compoſed of principles of very different degrees of volatility, might ſeem well adapted to it. This particularly happens when the principles of ſubſtances analyſed by this method have a great adheſion to each other; becauſe in this caſe a volatile principle drags along with it a portion of the fixed principle, which would never have been raiſed by the degree of heat employed without this adheſion, and as it were, participation of the volatility of the former with the latter. Frequently, therefore, the principles obtained by this method of analyſis are in part ſtill united with each other, and are far from the proper degree of purity. In this caſe it is neceſſary to have recourſe to new diſtillations, rectifications, and purifications, to obtain them ſufficiently pure and ſeparated from each other. This inconvenience particularly attends the analyſes by fire of moſt animal and vegetable ſubſtances, in which analyſes very volatile acids and alkalis are often procured, ſtill united with much ſuperfluous heavy oil. The beſt method of avoiding this inconvenience, or at leaſt of diminiſhing it as much as poſſible, is to manage very care-

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been formed of them. By a ſtrong heat it is whitened, hardened ſo as to be capable of ſtriking fire with ſteel, and rendered brittle. It has generally been conſidered as unfuſible by fire; but Mr. D'Arcet, in a Memoir of the French Academy for the year 1766, affirms, that by a violent and long-continued fire it is fuſible, and that it forms a black glaſs. This ſtone is inſoluble by acids.

fully the fire; for it is evident that a too ſtrong fire would readily confound all the principles of the ſubſtance to be analyſed.

A ſecond no leſs important remark concerning the analyſis by fire, is, that by this method the *proximate principles* of very compound bodies, ſuch as moſt vegetables, cannot be obtained; becauſe theſe proximate principles being themſelves very compound, and of a delicate mixture, cannot, for the moſt part, ſupport the action of fire without a total or partial decompoſition; or, at leaſt, without receiving ſuch conſiderable alterations that they can no longer be known. This inconvenience chiefly attends thoſe proximate principles which are not poſſeſſed of great volatility, as we may ſee from the example of mild and fat oils, of gummy, reſinous, ſaponaceous, and extractive parts of vegetables. Theſe principles cannot ever be procured by diſtillation ſuch as they were in the plant.

Theſe inconveniences have induced chemiſts, particularly the modern, to ſearch for other methods of decompoſing bodies, and ſeparating their principles.

They have found one method which wonderfully ſupplies in many caſes the defects of the analyſis by fire.

This ſecond method of decompoſing bodies is founded on the different degrees of ſolubility in moſt menſtruums, which the different principles poſſeſs. Thus when a body is compounded of ſeveral ſubſtances; one of which, for inſtance, is ſoluble only by ſpirit of wine, a ſecond is ſoluble only by water, and a third is ſoluble only by ether; theſe ſubſtances may be very eaſily ſeparated from each other, by ſubmitting ſucceſſively the compound body to the action of theſe menſtruums, each of which diſſolves that particular ſubſtance to which it has an affinity, and from which it may be afterwards eaſily ſeparated. This method of analyſis is excellent to ſeparate without any ſenſible alteration the greateſt part of the proximate principles of vegetables, and to obtain them as they exiſt in the plants. If, for inſtance, a vegetable matter contain gum, reſin, and an oil or oily concretion not ſoluble in ſpirit of wine; we may firſt deprive it by water of its mucilaginous and gummy parts, which may afterwards be obtained in their natural ſtate merely by evaporation of the water; then, by applying to this vegetable matter ſpirit of wine, we may extract its reſinous parts; and laſtly, we may, by treating it with ether, ſeparate its oily part, which could not be diſſolved by the water or the ſpirit of wine. It is afterwards eaſy to obtain the ſubſtances diſſolved by the ether and ſpirit of wine, pure and free from their menſtruums, either by evaporation, or by addition of much water, which ſeparates the oily and reſinous parts. *See* Spirit *of* Wine, *and* Ether.

As this method of ſeparating the principles of bodies is ſolely founded on the action of menſtruums, this kind of analyſis has been called Analysis *by* Menstruums.

What has been ſaid on this ſubject is ſufficient to ſhew its great utility. We may add, that in ſome caſes this is the only analyſis which can be applied, and by which a perfect and compleat ſeparation can be effected. If, for example, the body to be analyſed conſiſts of two ſubſtances which equally reſiſt the action of fire, as gold and ſilver, it is evident that theſe two ſubſtances cannot be ſeparated from each other but by means of a menſtruum which can only diſſolve one of them. Thus, by expoſing a maſs compoſed of gold and ſilver to aqua regia, which diſſolves the gold only, or to nitrous acid, which diſſolves only the ſilver, the ſeparation of theſe two metals may be effected. The operation called *Parting* ought then to be conſidered as the true analyſis by menſtruums. *See* Parting.

We may ſay the ſame of all decompoſitions and precipitations which are made in numberleſs chemical operations by intermediate ſubſtances, either by the humid or by the dry method, in different fuſions. In all theſe caſes, the intermediate ſubſtance employed effects the precipitation or ſeparation of the body intended to be ſeparated, by really diſſolving another body to which the former was united. Thus the analyſis by menſtruums is at leaſt of as extenſive utility as the analyſis by fire, ſince it takes place in almoſt all the operations of chemiſtry.

It is true, that in many caſes the analyſis by menſtruums, as well as that by fire, is incomplete. This inconvenience happens when there is in the compound body to be analyſed ſome intermediate ſubſtance, by means of which the menſtruum is rendered capable of acting upon ſome of the principles, which it ought not to do, in order to have a complete and perfect ſeparation. But theſe inconveniences may be prevented or remedied.

Frequently it is neceſſary, in order to make a perfect analyſis of bodies, to unite theſe two methods by fire and by menſtruums: the one may be made to aſſiſt the other; and from theſe combined means a decompoſition reſults much more perfect, and more accurate, than could have been obtained by either of them ſeparately. If, for inſtance, we intended to ſeparate from ſpirit of wine the ſuperabundant quantities of oil and water which are generally united with it, we ought, inſtead of diſtilling it alone, to mix with it ſome fixed alkali, or very dry earthy matter, and then to proceed to the diſtillation: theſe alkaline or earthy ſubſtances acting upon the oil and water will retain and fix them; by which means the ſpirit of wine is allowed to riſe much purer in diſtillation.

We ſhall ſay nothing more here upon analyſis in general. This ſubject is ſo extenſive, that to make particular applications of it, we ſhould be obliged to conſider all the objects in chemiſtry. Thoſe who know the uſe of general principles will eaſily apply theſe to particular operations; and longer details would be fatiguing and uſeleſs to others. It is nevertheleſs proper to mention the general articles which are related to this. *See* DECOMPOSITION, DISTILLATION, SUBLIMATION, PRECIPITATION, EXTRACTION, SOLUTION.

ANGELICA. *(w)*

ANIMAL. *(x)*

ANIME. *(y)*

ANISE. *(z)*

ANNOTTO. *(a)*

(w) ANGELICA. The root of this plant contains an eſſential oil, and a reſinous matter. *Neuman.*

(x) ANIMAL KINGDOM. *See* KINGDOM.

(y) ANIME, according to Neuman, is a reſin totally ſoluble in ſpirit of wine. It is called improperly *gum anime.* Other authors mention two ſubſtances to which this name is given, one of which is brought from India, and is reſinous: the other is brought from Braſil, and is ſimilar in appearance and inſolubility in ſpirit of wine, or in water, to the ſubſtance called *gum copal.* All the anime which is to be found in ſhops of druggiſts is of this latter kind; and if it does not proceed from the ſame tree as gum copal, is ſcarcely diſtinguiſhable from it.

(z) ANISE. The outer thin ſkin of the ſeeds of this plant contains an eſſential oil, and the kernel itſelf contains an inodorous, inſipid, expreſſible oil. *Neuman.*

(a) ANNOTTO is a red maſs extracted by infuſion in water, and fermentation from the pellicles of the ſeeds of an American tree. To water this maſs gives only a pale browniſh-yellow color, and is very little ſoluble in that liquid. It readily diſſolves in ſpirit of wine, and gives a bright orange color: hence it is uſeful as an ingredient in varniſhes and lacquers. By alkaline ſalts it is rendered ſoluble in water, without any change produced upon its color.

ANTIMONY. Antimony is a mineral of a metallic, ſhining, leaden color, the maſſes of which have no determinate figure, but are compoſed of long, brittle, parallel needles. It is compoſed of a ſemi-metallic ſubſtance called its *regulus*, united with ſulphur, as moſt metallic ſubſtances are in their mineral ſtate.

There are two kinds of antimony, namely, that which is called *native* or *mineral*, and is in the ſame ſtate as when it is dug out of the earth; and *fuſed antimony*, ſo named, becauſe it has been actually fuſed in order to ſeparate it from adhering ſtones and earths. This operation, which ought rather to be called liquation than fuſion, conſidering theſe words in their metallurgic ſenſe, is made in great perfection upon the grounds whence antimony is dug. The proceſs is very ſimple and eaſy. It conſiſts in placing the mineral in earthen pots, pierced in their bottoms with ſmall holes. Theſe pots are placed in a furnace, where they receive the neceſſary heat for the fuſion of the antimony. As it is very fuſible, (for it melts before it is red) this degree of heat is much leſs than is neceſſary for the fuſion of the earthy and ſtony matters mixed with it. The antimony thus melted runs through the holes at the bottom of the pots, and is received in other pots placed below, and defended from the heat as much as is poſſible. The antimony is allowed to cool and fix in theſe receivers, from which it therefore takes its form of cakes, in which it is ſold. The countries which furniſh moſt antimony are Hungary and Auvergne, whence the names *Hungarian antimony*, and *Auvergne antimony*. Antimony is alſo found in other countries, and in different forms; upon which ſubject conſult the article ORE *of* ANTIMONY.

As many remedies of great conſequence are prepared from antimony, and as alchemiſts have ſuppoſed it eſſential to the *great work*, a very great number of chemical operations have been made upon this mineral, the reſults of which are diſtinguiſhed by particular names. We ſhall here give a ſummary account of theſe operations, and ſhall make references for the particular details and explanations.

color. Wool and ſilk boiled in this ſolution acquire a deep, but not durable orange dye. Its colour is not changed by alum or by acids; but is diſcharged by ſoaps, and is deſtroyed by expoſure to air. It is ſaid to be an antidote to the poiſonous juice of manioc, or caſſava.

The metallic part of antimony is diſengaged from its ſulphur by ſeveral methods. The firſt and ſimpleſt is torrefaction, commonly called *Calcination of Antimony*. It conſiſts in expoſing crude antimony, groſly powdered, in a flat and ſhallow earthen veſſel, to the action of a moderate fire, care being taken to ſtir it conſtantly. During this calcination, the ſulphur, being leſs fixed than the metalline part, is gradually evaporated. The calcination is continued till no more ſulphureous vapors riſe. What remains after the calcination is the metallic part of the antimony ſeparated from the mineral ſulphur, and even deprived of part of its own inflammable principle. This ſubſtance is much more fixed and leſs fuſible than antimony, becauſe in general metallic earths are ſo much more fixed and leſs fuſible as they are deprived of more of their inflammable principle. It is called *Calx of Antimony*. It is of a grey aſh color. When taken internally it is violently emetic and purgative, whereas antimony is not poſſeſſed of theſe qualities, becauſe its metallic earth is inveloped by ſulphur, and thereby deprived of moſt of its properties.

Calx of antimony, expoſed to a great heat in a crucible, melts, and appears when cold a hard, compact, brittle, ſhining maſs. This melted matter is ſometimes tranſparent, and of a more or leſs deep hyacinthine color. It is then called *Glaſs of Antimony*, becauſe it has the appearance and properties of a vitrified ſubſtance.

Sometimes calx of antimony, when fuſed and cooled, becomes an opake brown maſs. It is then called *Liver of Antimony.*

Theſe differences proceed from the greater or leſs quantity of inflammable principle which remains united with the metallic earth of the antimony. They conſequently depend on the length and accuracy of the calcination.

When this calcination has been ſlight, and much inflammable matter remains united with the earth of antimony, then the calx produced is capable of melting with leſs heat, and the reſult is liver of antimony, which ought to be conſidered as an intermediate matter betwixt the vitrified and metallic ſtates.

If the calcinatoin has been more complete, the calx is of more difficult fuſion, and the reſult from it is a vitrified ſubſtance.

Laſtly, if the calcination has been as as perfect as is poſſible, the remaining calx is ſtill more refractory, and is even incapable of fuſion and vitrification.

The calx, the liver, and the glaſs of antimony, are violently emetic. The phenomena which they ſhew when treated with chemical agents, are ſo much more ſimilar to thoſe exhibited by the regulus of antimony, as they approach more to the reguline ſtate, that is to ſay, as they are more perfectly deprived of mineral ſulphur, and leſs deprived of their inflammable principle.

Theſe three preparations of antimony being treated in cloſe veſſels, and fuſed with matters capable of furniſhing phlogiſton, ſuch as the black flux, are reduced not into antimony from which they were originally produced, but into a ſemi-metallic, hard, brittle ſubſtance, of a dull white color, and compoſed of ſhining facets. This ſubſtance is called *Regulus of Antimony.* The cauſe of this change is, that by calcination this mineral is deprived of all the ſulphur which is found united with its ſemi-metallic or reguline ſubſtance, and that this ſulphur is not reſtored to it in the reduction above-mentioned. If then it be intended to reſtore the properties of antimony to its calx, liver, glaſs, or regulus, it ought to be combined by fuſion not only with phlogiſton, but alſo with a proper quantity of mineral ſulphur.

Antimony may be diſengaged from its ſulphur, and at the ſame time reduced either into regulus, liver, or white calx entirely deprived of its phlogiſton, by ſeveral other proceſſes, much ſhorter and more expeditious than calcination, which is always very long.

If a mixture of four parts of crude antimony pulveriſed, three parts of tartar, and one part and a half of nitre, be projected at different times into a large red-hot crucible, and ſurrounded with burning coals; and when the detonation is finiſhed, the fire raiſed ſo as the matter ſhall be fuſed; then upon breaking the crucible when cool, a maſs is found conſiſting of two diſtinct ſubſtances, and which may be ſeparated from each other by the ſtroke of a hammer. The lower ſubſtance is the reguline metallic part, and is called *Regulus of Antimony.* The ſubſtance lying above this is called *Scoria of the Regulus of Antimony.* This ſcoria is alkaline and acrid: it attracts the moiſture of the air, and is compoſed, 1. Of the alkalis of the nitre and of the tartar alkaliſed by each other in the operation; 2. Of a portion of the ſulphur of the antimony, which during the operation united with the alkali and formed a liver of ſulphur; 3. A portion of reguline ſubſtance of antimony diſſolved by this liver of ſulphur; 4. Laſtly, ſome vitriolated tartar which was formed by a part of the acid of the ſulphur combining during the detonation with the fixed alkali.

From the ſolution of the ſcoria of the regulus of antimony in water, a yellow reddiſh matter is depoſited in a certain time, which is nothing elſe than a part of the ſulphur and of the regulus of antimony which quit the alkali without ſeparating from each other; conſequently it is a kind of *Kermes*. When the ſolution of this ſcoria is ſaturated with any acid, a pretty large quantity of reddiſh matter is precipitated, which is compoſed, like the former, of ſulphur and reguline parts. *This matter is called* SULPHUR (GOLDEN) *of* ANTIMONY, *which ſee.*

Theſe two precipitates, and particularly the latter, are very emetic, although in them the reguline part is, (as in antimony, which has no emetic quality) united with a large portion of ſulphur. The true reaſon of this difference is, that in crude antimony the ſulphur is much more intimately and ſtrongly united to the ſemi-metallic part than it is in the golden ſulphur.

Moſt metals, as iron, copper, tin, lead, and ſilver have a greater affinity to ſulphur than the regulus of antimony has. Hence this regulus may be precipitated in fuſion, and its ſulphur may be ſeparated by means of theſe metals. The regulus thus obtained is called the *Regulus of the Metals*. The name of the particular metal employed to make this precipitation is added. Thus it is called, the *Regulus of Tin*, the *Regulus of Copper*, the *Martial Regulus*, according to the metal uſed in the operation. Iron is moſt frequently employed to make this regulus, becauſe of all metals it has the greateſt affinity to ſulphur, and for that reaſon ſeparates moſt eaſily and perfectly the reguline part. *See* REGULUS *of* ANTIMONY (MARTIAL).

If inſtead of detonating antimony with a ſufficient proportion of nitre to obtain the regulus, equal parts of theſe two ſubſtances are employed; then, after the detonation, no regulus will be found at the bottom of the crucible, but a brown, opake, brittle maſs, of no metallic appearance; in a word, ſimilar to that maſs which is obtained by melting the calx of antimony alone, when too little dephlogiſticated to be capable of vitrification. This maſs is, properly ſpeaking, the ſubſtance called *Liver of Antimony*, from its color, which ſomewhat reſembles that of the liver of animals. By this proceſs the liver is always made in ſmall chemical laboratories. But it is ſaid that in Holland, where many chemical operations are objects of manufacture, the liver of antimony is made by melting the calx of this mineral alone, ſufficiently dephlogiſticated. The liver of antimony prepared by either of theſe methods is a violent emetic and purgative. Several diſpenſatories require it to be employed in the preparation of *emetic tartar*. *See this word.* It is alſo uſed to purge horſes.

When in this operation of liver of antimony by nitre, the matter has been well fuſed, it is obſervable that the maſs found upon breaking the crucible is compoſed of two diſtinct ſubſtances. The liver of antimony, being the heavier of the two, is at the bottom; and above it lies a lighter and more ſaline matter, called the *ſcoria*, which may be ſeparated by a hammer. This ſcoria is nearly of the ſame nature as that of the ordinary regulus. It is very acrid and alkaline, and contains vitriolated tartar, and liver of ſulphur, by which ſome liver of antimony is kept diſſolved. A golden ſulphur of antimony may be alſo precipitated from this ſcoria by any acid.

When in the operation of the liver of antimony, the fuſion has not been ſufficient, or the mixture has been cooled too ſuddenly, then the ſcoria remains mixed with the liver of antimony, which it in ſome meaſure keeps diſſolved.

Laſtly, in detonating antimony with thrice its weight of nitre, after the operation, a maſs perfectly white and void of color is found. This maſs is a mixture of calx of antimony with certain ſaline matters. Theſe are, 1. Nitre alkaliſed by the phlogiſton of the ſulphur, and of the regulus of antimony; 2. Vitriolated tartar, proceeding from a portion of the acid of the ſulphur, combined with the alkali of the nitre; 3. A portion of nitre undecompoſed.

As to the calx of antimony obtained by this operation, it is perfectly white, becauſe entirely deprived by nitre not only of all the mineral ſulphur, but alſo of its own phlogiſton.

This calx well waſhed, ſo as to be cleanſed from the ſalts, is called *Diaphoretic Mineral*, *Diaphoretic Antimony*, and *White Calx of Antimony*. It is neither emetic nor purgative; for which reaſon a diaphoretic quality has been attributed to it.

The white calx of antimony is not ſoluble in acids. It is exceedingly fixed, and often refractory, being capable of ſuſtaining the greateſt violence of fire without vitrifying or melting. All theſe properties, ſo different from thoſe of the regulus, the liver, and the glaſs of antimony, proceed from its being entirely diveſted of phlogiſton by nitre.

The quantity of nitre employed in this operation is more than ſufficient to dephlogiſticate entirely all the earth of the antimony, ſince in the ſcoria is found ſome nitre undecompoſed, becauſe there was not phlogiſton enough in the antimony for that purpoſe.

Theſe phenomena of the calcination of antimony, which are conformable to thoſe of all other metallic calcinations, prove in a ſatisfactory manner, that metallic matters owe their volatility, their fuſibility, and their ſolubility in acids to their phlogiſton.

The maſs remaining in the crucible after the detonation, in the operation of diaphoretic antimony, and which conſequently contains the calx of antimony and the ſalts reſulting from the operation, receives aperitive, and even purgative qualities from the ſalts contained in it. It is called *Unwaſhed Diaphoretic*. It forms alſo the ſubſtance called the *Reſolvent of Rotrou*.

When the reſult of the detonation of diaphoretic antimony is waſhed, in order to cleanſe it from the ſalts, the water diſſolves not only the ſaline matters, but alſo the fineſt part of the calx of antimony adhering to theſe ſalts. This matter ſeparates and precipitates in form of a very white and fine powder; for which reaſon it has been called *Pearl-Matter*. It has alſo been named the *Ceruſs of Antimony*, and very improperly the *Fixed Sulphur of Antimony*. For it is evident from the nature of the operation, that no ſulphur can remain in it, nor even any inflammable matter. The pearl matter alſo gives no marks of ſulphur contained, and has abſolutely the ſame properties as diaphoretic antimony; and if it differs in any thing, it is in being more perfectly calcined.

The white calx of antimony and the pearl-matter may be reduced into regulus by fuſion in cloſe veſſels, with a reducing flux, as black flux, but only in part, and with conſiderable loſs.

In all theſe operations, where antimony is expoſed to a fuſing heat, a conſiderable quantity of volatile matter riſes in ſmoke, and adheres in form of a meal or fine powder to any cold body it meets. This is called *Flowers of Antimony*, which are nothing elſe than the ſemi-metallic part of the antimony, more or leſs deprived of the ſulphur and phlogiſton; but never entirely of the latter; and they are therefore violently emetic.

In the chemical operations for procuring theſe flowers, only antimony itſelf or its regulus are employed. For this purpoſe a convenient apparatus and veſſels are uſed. *See* FLOWERS *of* ANTIMONY, *and* FLOWERS *of* REGULUS *of* ANTIMONY.

When crude antimony is boiled in a lixivium of fixed alkali, a liver of ſulphur is formed from the combination of this alkali with the ſulphur of the antimony, by which the metalline part of the antimony is diſſolved. But the alkali, by its being diſſolved in water, having but a ſlight union with the ſulphur, this antimoniated liver of ſulphur cannot be kept ſuſpended in the water, when the heat of that fluid is leſs, or much leſs than is ſufficient to make it boil. Hence when the liquor cools, it becomes turbid; and a brick-colored ſediment falls down, which has been called *Kermes Mineral.* This precipitate drags down along with it, according to a general rule of all precipitates, a portion of the alkali by which it was kept diſſolved. But this portion of alkali is very ſmall. For this reaſon alſo the kermes cannot be kept diſſolved but in very hot water. Hence it appears that kermes is nothing but an antimoniated liver of ſulphur, containing the ſmalleſt poſſible quantity of alkali, or a ſuperabundant quantity of ſulphur and regulus of antimony.

Kermes may alſo be made by fuſion, that is, by melting in a crucible dry alkaline ſalt and crude antimony, and then diſſolving the combination in boiling water. The ſame phenomena appear, as in the preceding operation, and for the ſame reaſons.

Kermes is a preparation of great utility and importance in medicine. *See the details, the preparation of Kermes, and the theory of it more extenſively, as well as its medicinal virtues, at the article* KERMES MINERAL.

Acids difficultly diſſolve regulus of antimony. To diſſolve it by the vitriolic acid, the ſame proceſs muſt be uſed as in the ſolution of mercury by this acid for the preparation of turbith mineral: that is, to employ a very concentrated acid, and to diſtill in cloſe veſſels. The ſame phenomena alſo occur in this operation as in that for turbith mineral: a very ſuffocating ſulphureous acid riſes; and as Mr. Geoffroy obſerves, a true ſulphur ſublimes, and adheres to the neck of the retort: a white ſaline tumified maſs remains in the veſſel. When the veſſels are unluted, a white fume iſſues like the ſmoking ſpirit of Libavius. Theſe phenomena of the production of volatile ſulphureous acid, and of concrete ſulphur, are evidently effects of the combination of the vitriolic acid with the phlogiſton of the regulus of antimony.

The nitrous acid does, properly ſpeaking, only corrode and dephlogiſticate the regulus of antimony, which it converts into a white calx. It diſſolves a little better this reguline part, when it is applied to the antimony itſelf. This ſolution, as Mr. Geoffroy obſerves, acquires a blueiſh greeniſh color. When only a ſufficient quantity of acid is employed, it may be ſeen to inſert itſelf betwixt the ſtriæ of the antimony, and there form ſmall cryſtals.

Marine acid does not ſenſibly act upon antimony nor its regulus. It only detaches from the antimony, in lumps, ſome light and ſulphureous flocks.

Aqua regia moſt directly and completely diſſolves regulus of antimony. For this operation, it is proper to employ an aqua regia compoſed of four parts of ſpirit of nitre, and one part of ſpirit of ſalt. This menſtruum is digeſted in a ſand-bath with a gentle heat upon bits of regulus of antimony, which are added ſucceſſively, ſo that one ſhall not be added till the former are diſſolved. By means of this management, directed by Mr. Geoffroy in the Memoirs of the Academy of Sciences, aqua regia can diſſolve about a ſixteenth part of its weight of regulus of antimony. This ſolution has a beautiful golden color, which diſappears by the evaporation of white fumes continually riſing from it.

The aqua regia above deſcribed is alſo very proper to diſſolve the reguline part of the crude antimony, and the ſolution even ſucceeds better in this way. This is applicable to all the ſolvents of the regulus of antimony.

The combination of marine acid with regulus of antimony, which ſucceeds ſo ill by applying this acid directly to the ſemi-metal, may be much better made by employing a marine acid previouſly combined with mercury in corroſive ſublimate.

When regulus of antimony or powdered crude antimony is mixed with corroſive ſublimate, and this mixture diſtilled, the marine acid, having a ſtronger affinity with regulus of antimony than with mercury, quits the latter metallic ſubſtance to unite with the former; and from this a combination reſults which paſſes in diſtillation, and has a butyraceous appearance. It is a very corroſive metallic ſalt, and is called the *Butter of Antimony*.

When the regulus is employed to make the butter of antimony, the mercury is ſeparated from the acid of the corroſive ſublimate, and paſſes over in its metallic and fluid ſtate towards the end of the operation, and when the fire is encreaſed.

But if antimony has been employed to make this butter, a cinnabar may be ſublimed, by increaſing the fire after the butter of antimony has paſſed over in diſtillation. This cinnabar reſults from the union of the ſulphur of the antimony with the mercury, and is called *Cinnabar of Antimony. See* BUTTER *and* CINNABAR *of* ANTIMONY.

Butter of antimony is then the reſult of a combination of the metallic part of antimony with marine acid in its higheſt degree of concentration, and is therefore a powerful cauſtic. It may be rendered liquid by a ſmall quantity of water; but if diluted with much water, then the greateſt part of the regulus ſeparates from the menſtruum, and precipitates in the ſtate of a white powder, which has been called *Powder of Algaroth*, and *Mercury of Life. See theſe words.*

The powder of algaroth is a very violent emetic. Mr. Beaumé has aſcertained, by very accurate experiments, that when it is ſufficiently waſhed it does not retain a particle of marine acid.

The liquor in which the powder of algaroth is precipitated contains all the marine acid of the butter of antimony, with a portion of the reguline part, which may be ſeparated from it by precipitation with an alkali. This liquor has been named *Philoſophical Spirit of Vitriol*; which name is improper, ſince it contains no vitriolic acid.

Nitrous acid poured upon butter of antimony diſſolves it eaſily, and even violently. When this ſolution has been made gradually and cautiouſly, a tranſparent ſolution is obtained impregnated with much regulus of antimony.

As in this operation the added nitrous acid forms with the marine acid, already united with the regulus in the butter of antimony, an aqua regia; and as aqua regia is the beſt ſolvent of this ſemi-metallic ſubſtance, a new ſolution takes place by the addition of this nitrous acid, entirely ſimilar, as to its concomitant phenomena, to the ſolutions of metals by this acid, not previouſly diſſolved by any other. This new ſolution is even ſo impetuous, that when the quantity of matter is conſiderable, it is apt to be thrown violently out of the containing veſſels.

Butter of antimony is entirely changed by its union with nitrous acid. This acid, as is uſual, ſeized upon the inflammable part of the regulus of antimony which the marine had left unchanged: it diminiſhes the adheſion of the marine acid with the regulus. Hence it happens that this new combination of regulus of antimony with the acids of aqua regia, when dried and calcined, no longer poſſeſſes the volatility of the butter of antimony. Inſtead then of ſubliming or paſſing in diſtillation without decompoſition, as the butter does, the new compound reſiſts the action of fire, is decompoſed, lets its acids eſcape, and remains in the ſtate of a white powder.

If freſh nitrous acid be twice poured upon this white powder, and each time the matter evaporated and calcined, the regulus of antimony is then reduced to a white earthy ſubſtance, indiſſoluble in the nitrous acid, entirely fixed and unfuſible, and poſſeſſed of no emetic or purgative qualities. This preparation has been called *Bezoar mineral. See this word.*

This operation is one of thoſe which proves moſt ſenſibly the power of the nitrous acid to calcine metallic ſubſtances, by depriving them of their phlogiſton.It alſo proves that it is chiefly by means of this phlogiſton that the nitrous acid diſſolves theſe ſubſtances, ſince it cannot diſſolve bezoar mineral, diaphoretic antimony, nor any other ſimilarly dephlogiſticated metallic ſubſtances.

ANNEAL. Annealing conſiſts in making metals red-hot which have become hard and ſtiff by frequent percuſſion, or by a ſtrong compreſſion, in order to reſtore their former malleability and tractability. All metals have the ſingular property of becoming more or leſs hard, untractable, and unmalleable, after they have been ſtruck ſome time with a hammer. It ſeems as if ſomething happened to them ſimilar to the effect produced by the tempering of ſteel. Metals thus affected become more elaſtic than before, but, at the ſame time, more brittle. They are more ſenſibly affected in this manner, in proportion as they are naturally harder. Copper is ſo much affected, and even gold and ſilver, by hammering, that they ſoon ceaſe to be malleable, and are apt to ſplit and crack, inſtead of being extended, under the hammer. This labor therefore muſt be often interrupted, to ſoften and reſtore malleability to metals. This is effected by making them red-hot, which the workmen call *annealing*. Thus heat produces the ſame effect on metals in the ſtate deſcribed, as it does upon tempered ſteel: for if the hardeſt tempered ſteel be made red-hot, and cooled ſlowly, it becomes as tractable and ductile as the ſofteſt iron.

There is alſo an annealing for works made of glaſs. It conſiſts in placing them, while newly made and ſtill hot, in an oven or furnace, where they very ſlowly cool. This annealing for bottles and other glaſs utenſils is quite neceſſary to render them ſerviceable; for all glaſs which is cooled ſuddenly is liable to be broken, not only by the leaſt change of heat and cold, but even by the ſlighteſt force.

APYROUS. This word is applied to denote that property of ſome bodies, by which they reſiſt the moſt violent fire without any ſenſible alteration. Apyrous bodies ought to be diſtinguiſhed from thoſe which are *refractory*. Refractory ſubſtances are thoſe which cannot by violent heat be fuſed, whatever other alteration they may ſuſtain. But a body, properly ſpeaking, apyrous, can neither be fuſed by heat, nor can undergo any other change. Hence it follows, that all apyrous ſubſtances are alſo refractory, but that every refractory ſubſtance is not apyrous. Very pure calcareous ſtones, for inſtance, are refractory, becauſe they never melt without addition of other ſubſtance: but they are not apyrous; becauſe by fire their weight is conſiderably diminiſhed, the adheſion of their integrant parts is deſtroyed, and all their eſſential properties are changed by their converſion into quicklime. On the contrary, a very clear and pure diamond is apyrous, becauſe the ſtrongeſt fire is incapable not only of melting it, but alſo of producing upon it any other ſenſible alteration; ſo that a diamond which has been a long time expoſed to the moſt intenſe heat, is found to be the ſame in all reſpects as it was before. (b)

Perhaps there is no body in nature eſſentially and rigorouſly apyrous. This too is very probable; but it is ſufficient that there be bodies apyrous relatively to the degree of fire which art can produce, to entitle them to that name.

AQUA-FORTIS. Aqua-fortis is a name given by artiſts and manufacturers to nitrous acid, from its diſſolving power. As it is not the concentrated and ſmoking nitrous acid which is employed in the arts, it ſeems that the name aqua-fortis may be retained for that acid which has not theſe qualities.

Moſt artiſts who uſe nitrous acid, call the purer and ſtronger kind, which is alſo conſiderably dearer, by the name of *Spirit of Nitre*. For the properties of this acid, *ſee* ACID (NITROUS); and for the diſtillation of it, *ſee* SPIRIT *of* NITRE.

(b) Some late experiments have ſhewn that diamonds may be entirely diſſipated or evaporated by heat, and are therefore not entitled to be ranked amongſt apyrous ſubſtances. *See* DIAMONDS.

In the manufacture of ſoap, the cauſtic alkaline lixivium is called alſo the *ſtrong water*, or *ſoap-lees*, or *lixivium of ſoap-boilers*. *See* LIXIVIUM.

AQUA-REGIA. Aqua-regia is a mixture of the nitrous and marine acids. Theſe two acids are mixed to obtain a menſtruum capable of acting upon certain bodies which no pure acid can diſſolve, or but imperfectly; particularly gold and platina cannot be diſſolved in their aggregated ſtate by any other acid than by aqua-regia. Tin and regulus of antimony are better and more eaſily diſſolved by aqua-regia than by any other acid.

This menſtruum may be made either by merely mixing the ſpirit of nitre with ſpirit of ſalt, or by diſſolving in ſpirit of nitre a ſalt containing marine acid, and particularly ſal ammoniac and common ſalt. Laſtly, it may be well made by diſtilling nitrous acid from either of theſe ſalts; becauſe nitrous acid, being capable of diſengaging marine acid from theſe ſalts, does actually diſengage it, either by ſimply diſſolving them in nitrous acid, or by diſtillation.

The only difference betwixt the ſeveral ſorts of aqua-regia, prepared in theſe different manners, is, that the aqua-regia made by merely diſſolving ſal ammoniac or common ſalt in nitrous acid contains ammoniacal or cubic nitre, and that theſe neutral ſalts do not exiſt in the aqua-regia made by mixture of the two acids, or by diſtillation.

The preſence of theſe neutral ſalts in aqua-regia does not injure its diſſolving powers. Accordingly, as the aqua-regia which contains them is the eaſieſt prepared, and leaſt expenſive, it is more generally uſed than the others. But it is neceſſary to obſerve, that the ammoniacal nitre in the aqua-regia may occaſion conſiderable differences in the nature of the precipitates made from ſolutions of metals in this menſtruum, by ſeparating from theſe precipitates any of thoſe metallic ſubſtances which it is capable of diſſolving, and alſo by a portion of it adhering to precipitates. For inſtance, gold precipitated by a fixed alkali from an aqua-regia made by mixing the pure nitrous and marine acids, does not fulminate; whereas it does fulminate when precipitated from an aqua-regia made by diſſolving ſal ammoniac in nitrous acid. *See* PRECIPITATES; *and* GOLD (FULMINATING).

The mixture of the nitrous and marine acids preſents a very ſingular and remarkable phenomenon; which is, that the vapors of this mixture are more expanſive and more difficult to be confined than the vapors of either of the acids

before

before mixing. This proves a re-action of theſe acids upon each other. This phenomenon is very little ſenſible when the acids employed contain much ſuperabundant water; but is more manifeſt in proportion as theſe are more concentrated. I have obſerved, that upon mixing moderately ſmoaking nitrous and marine acids, which had remained without occaſioning any diſturbance in their bottles, an aqua-regia has been formed infinitely more ſmoaking, and which has made the ſtopper fly out of the containing bottle, particularly in weather ſomewhat warm. Mr. Beaumé, when diſtilling a pretty ſtrong nitrous acid upon ſal ammoniac, obſerved, that the vapors which paſſed were ſo elaſtic, that notwithſtanding every precaution that could be taken in ſuch a caſe, it was impoſſible to continue the diſtillation.

As to the proportions of nitrous and marine acids, or of ſal ammoniac, which ought to be employed for the preparation of aqua-regia, there are no eſtabliſhed rules. Common aqua-regia is made by diſſolving four ounces of ſal ammoniac in ſixteen ounces of nitrous acid. But theſe proportions ought to be varied according to the nature of the ſolutions intended.

To diſſolve, for example, the greateſt poſſible quantity of platina, the beſt proportion is equal parts of the two acids.

To diſſolve the greateſt quantity of regulus of antimony, the aqua-regia ought to be compoſed of four parts of nitrous acid to one of marine.

In general, the greater the proportion of marine acid, or of ſal ammoniac, is in aqua-regia, the leſs are the imperfect metals, and particularly tin calcined and precipitated by it. An aqua-regia, compoſed of two parts of ſpirit of nitre and one part of ſpirit of ſal ammoniac, makes a clear ſolution of nearly an equal weight of tin, without forming any precipitate: but for this purpoſe, the operation muſt be performed ſlowly, and heat muſt be avoided as much as poſſible. *See* GOLD, PLATINA, TIN, *and* REGULUS *of* ANTIMONY. *(c)*

AQUA-

(c) Aqua-regia does not diſſolve ſilver: but when the quantity of marine acid contained in the aqua-regia is very ſmall, the acid of nitre does then diſſolve ſilver, which is immediately afterwards attacked by the marine acid, with which it forms the metallic ſalt called *luna cornea*, and is precipitated. Aqua-regia diſſolves a larger quantity of lead than marine acid. All the other

AQUA-SECUNDA. This is nothing elſe than aqua-fortis diluted with much pure water. It is employed in ſeveral arts to clean the ſurface of metals and of certain ſtones, and for ſome other purpoſes.

AQUA-VITÆ. Aqua-vitæ is the ſpirituous part obtained by a firſt diſtillation from wine, or any other liquor which has undergone the vinous fermentation. It is, properly ſpeaking, ardent ſpirit, or ſpirit of wine.

To make the aqua-vitæ that is ſold in commerce, wine is put in large copper alembics or ſtills, to which worms are fitted, and the diſtillation is ſo conducted that the liquor flows out of the beak of the ſtill in a conſtant ſtream, and is continued till the liquor begins to be no longer inflammable.

It is evident that this diſtillation, being haſtily and unartfully performed, can only furniſh a very impure ſpirit of wine, mixed with ſeveral of the other principles of the wine employed. Thus aqua-vitæ contains much ſuperabundant water, and much oil of wine, ſubſtances entirely foreign to what is properly called ſpirit of wine.

Theſe heterogeneous matters contained in aqua-vitæ prevent it from being employed in chemical operations. To purify it, and change it into ſpirit of wine, it muſt be again diſtilled and rectified. *See* SPIRIT *of* WINE.

AQUILA ALBA. (*d*)

ARBOR DIANÆ. The arbor Dianæ is the reſult of a chemical operation, by which particles of ſilver, previouſly diſſolved in nitrous acid, are capable of arranging themſelves in the form of a ſhrub. Chemiſts have called this *Arbor Dianæ*, from the ſilver which they alſo call Diana, or the Moon. The following proceſs given by Lemeri for making the arbor Dianæ ſucceeds well:

" Take an ounce of fine ſilver, diſſolve it in a ſufficient " quantity of ſpirit of nitre, very pure and moderately " ſtrong; mix this ſolution of ſilver in a matraſs with

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other metals it perfectly diſſolves. According to Gellert's Table, the ſubſtances which aqua-regia diſſolves are placed in the following order, beginning with thoſe to which it moſt powerfully unites: Phlogiſton, zinc, iron, regulus of cobalt, copper, tin, arſenic, biſmuth, mercury, lead, regulus of antimony, gold. In this table copper is erroneouſly placed before tin, as the latter metal readily precipitates the former.

(*d*) AQUILA ALBA is a name given to ſweet mercury. *See* MERCURY (SWEET).

“ about twenty ounces of diſtilled water; add to this mix-
“ ture two ounces of mercury, and let the whole remain
“ at reſt. During a ſpace of about forty days, a kind of
“ ſilver tree will be performed upon the mercury, with
“ branches reſembling vegetable ramifications.”

As this proceſs is very long, we ſhall here add another much ſhorter, taken from a memoir of Mr. Homberg, and quoted by Mr. Baron, in his edition of Lemeri's Chemiſtry.

“ Make an amalgam without heat, of four drams of
“ filings of ſilver, or, ſtill better, of ſilver-leaf, and of
“ two drams of mercury (*See* AMALGAM); diſſolve this
“ amalgam in four ounces, or a ſufficient quantity, of
“ ſpirit of nitre pure and moderately ſtrong; dilute this
“ ſolution in about a pound and a half of diſtilled water;
“ ſhake the mixture, and preſerve it in a bottle with a glaſs-
“ ſtopper: when this preparation is to be uſed, an ounce
“ of it is to be put into a phial together with about the
“ ſize of a pea of an amalgam of gold or of ſilver, which
“ ought to be ſoft as butter; and the whole is to remain
“ at reſt: ſoon afterwards, ſmall filaments are to be ſeen
“ iſſuing from the ſmall amalgam, which quickly encreaſe,
“ branch out on both ſides, and take the form of ſhrubs.”

This experiment, which is generally conſidered merely as curious and amuſing, is founded on many of the eſſential properties of the ſubſtances employed. As mercury has a ſtronger affinity than ſilver to nitrous acid, it obliges this metal to ſeparate and precipitate. But in this precipitation there are two eſſential particulars: the firſt is the color of the ſilver precipitated, which on this occaſion appears in its natural form and metallic brilliancy. The cauſe of this is, that it was precipitated by a metallic ſubſtance; for it appears, that in general this happens whenever one metal is precipitated by another metal; whereas metals precipitated by any other ſubſtance are always in form of calxes, or earthy precipitates, without any metallic appearance. *See* PRECIPITATION.

The ſecond remark to be made on the precipitation of ſilver in this experiment is, the ſingular arrangement taken by the particles of ſilver on the ſurface of the mercury one after another, according as they are ſeparated from the nitrous acid. We cannot but perceive in this phenomenon a very ſenſible effect of the attraction or affinity of the integrant parts of the ſame ſubſtance, or of two ſimilar ſubſtances to each other. In fact, it can only proceed from this affinity which the particles of ſilver firſt ſeparated from the nitrous acid have with the mercury, that they rather attach themſelves to the ſurface of that metallic ſubſtance, than to any part of the veſſel or of the liquor; and it alſo proceeds from this tendency which the particles of ſilver have to each other, that thoſe which are afterwards ſeparated from the nitrous acid adhere to the particles already attached to the mercury, and to each other, rather than to any other body.

As to the neceſſary conditions for this experiment of the arbor Dianæ, it has been already recommended to employ very pure ſilver, nitrous acid, and water; becauſe the greateſt part of the extraneous matters with which theſe ſubſtances are generally mixed, are capable of precipitating the ſilver, which in the preſent experiment ought not to be ſeparated but by mercury. *See* SILVER, *and* PARTING.

In the ſecond place, it is abſolutely neceſſary to dilute in much water the ſolution of ſilver; 1. To avoid the formation of cryſtals of ſilver, which might take place if this ſolution was too concentrated, theſe being a cryſtallization of ſilver in a ſaline ſtate, very different from the arbor Dianæ which is required. *See* CRYSTALS *of* SILVER. 2. Becauſe if the ſoluion of ſilver was concentrated, the particles of ſilver would be precipitated too faſt, and in too great quantity; by which they would be prevented from applying themſelves regularly to each other, and would be thrown down confuſedly.

In the third place, it is neceſſary that the nitrous acid ſhould be ſaturated with ſilver before it is diluted with water, otherwiſe the unſaturated part of the acid muſt firſt diſſolve its proper quantity of ſilver or mercury, before the precipitation can take place, which would lengthen the experiment ſo much more, as the quantity of water with which the ſolution was diluted was greater.

ARCANUM CORALLINUM. This is nothing elſe than *red precipitate*, on which ſpirit of wine has been two or three times burnt, with an intention of rendering it milder. *See* PRECIPITATE (RED).

ARCANUM DUPLICATUM. This Latin name, which ſignifies *the double ſecret*, is one of the moſt generally known ſalts. It is the ſalt compoſed of vitriolic acid united with vegetable fixed alkali, and therefore does not differ from the *Sal de duobus*, and *vitriolated tartar*. *See* TARTAR (VITRIOLATED).

ARCHIL. (e)

ARGENTUM MUSIVUM. (f)

ARRACK. (g)

ARSENIC. Arſenic, or *white arſenic*, is, properly ſpeaking, nothing but the flowers or calx of regulus of arſenic.

This ſubſtance has ſingular properties, which render it the only one of its kind.

It is at once a metallic earth and a ſaline ſubſtance. It reſembles all metallic calxes in its capacity of combining with phlogiſton, and of being thereby changed into a true ſemi-metal.

But it very eſſentially differs from all metallic calxes and earths.

1. In being conſtantly volatile; whereas all other calxes of metals, and even of the moſt volatile ſemi-metals, are very fixed when deprived of phlogiſton.

2. Metallic calxes, ſo far from being ſoluble in water, are even for the moſt part indiſſoluble in the ſtrongeſt acids. White arſenic, on the contrary, is ſoluble, not only in all acids, but alſo in water itſelf, as ſaline matters are.

According to Mr. Brandt (*Acta Eruditorum Upſal. de Semimetallis*, 1733), arſenic may be diſſolved in fourteen or fifteen times its weight of water, by help of a boiling heat, and tranſparent yellow cryſtals may be obtained by evaporating this ſolution.

(e) Archil, Archilla, Rocella, or Orseille, is a white moſs which grows in the Canary and Cape de Verd iſlands, and according to Linnæus, on the weſtern coaſt of England. From this plant is prepared, by grinding and moiſtening with volatile alkali, a beautiful purple dye, which is not durable, but is chiefly uſed to give a bloom, as it is called, to other colors. By adding ſolution of tin to an infuſion of archil in water, a durable ſcarlet dye is produced, as Mr. Hellót ſays. The color of archil may be extracted by water, by volatile ſpirits, or by ſpirit of wine. It loſes its color in glaſs tubes hermetically ſealed, and reſumes it upon expoſure to air. A ſolution of archil in water gives a permanent and deep ſtain of a purpliſh color to marble.

(f) Argentum Musivum or Mosaicum is a maſs conſiſting of ſilver-like flakes, uſed for the coloring of plaſter figures, and for other purpoſes, as a pigment. It conſiſts of an amalgam of equal parts of tin, biſmuth, and mercury. It is to be mixed with white of eggs, or ſpirit varniſh, and then applied to the intended work, which is afterwards to be burniſhed.

(f) Arrack is a vinous ſpirit obtained by diſtallation in the Eaſt-Indies, from rice or ſugar, as is ſaid, fermented with the juice of coco-nuts.

3. Metallic calxes, when perfectly calcined, (the calx of the regulus of antimony not excepted) are entirely free from ſmell, taſte, or other action upon the human body. On the contrary, arſenic always preſerves a ſtrong alliaceous ſmell, and when put on the tongue, it excites an impreſſion of acrimony and heat, which produces an involuntary ſpitting; when taken internally, or even when applied externally, it produces the moſt terrible and violent effects of a corroſive poiſon.

4. No kind of earth, not even the metallic earths, can contract an union with metallic ſubſtances. Arſenic eaſily unites with all metals and ſemi-metals, with the ſame degrees of affinity that the regulus of antimony does, that is to ſay, in the order following, according to Mr. Cramer: iron, copper, tin, lead, ſilver, gold.

It is proper to obſerve, that arſenic renders all the metals with which it is united brittle. It renders gold of a greyiſh color in its broken ſurface, ſilver of a deep grey, and copper white. Tin becomes by mixture with arſenic much harder and more unfuſible. Lead becomes very hard and very brittle, and it changes iron into a blackiſh maſs. Theſe obſervations are taken from Mr. Brandt's Memoir quoted above.

5. The more metallic calxes are deprived of phlogiſton, the more unfuſible they are rendered. On the contrary, arſenic is always very fuſible. Its volatility alone prevents its perfect fuſion. It volatilizes, vitrifies, and ſcorifies all ſolid bodies, excepting gold, ſilver and platina.

6. Earths and metallic calxes have no action upon nitre, which (as is obſerved under the article *Nitre)* can be decompoſed only by phlogiſton, by vitriolic acid, and by ſedative ſalt. Arſenic decompoſes nitre with the greateſt facility, not by combining with and deſtroying its acid, as phlogiſton does; but by diſengaging it, and uniting in its place with the alkali, as the vitriolic acid and ſedative ſalt do.

Stahl and Kunkel both knew this property which arſenic poſſeſſes of decompoſing nitre, and of diſengaging its acid.

Stahl directs how to prepare by means of arſenic a very volatile nitrous acid, extremely concentrated, of a penetrating fetid ſmell, and blue color, although its vapors are red. This color, according to Mr. Beaumé's obſervation, is cauſed by the water which muſt neceſſarily be put in the receiver to condenſe the vapors of this very ſtrong and difficultly condenſible acid.

Kunkel alſo directs to make an aqua-fortis ſimilar to that of Stahl, but by a much clearer and ſimpler proceſs, ſince he decompoſes nitre by arſenic alone; whereas Stahl employs in his mixture a martial vitriol calcined till it becomes red, and does not uſe pure arſenic, but a combination of equal parts of arſenic with antimony and ſulphur, a combination which the chemiſts have called *Pirmieſon*, or *Lapis de tribus*.

These two chemiſts contented themſelves with examining the properties of the ſpirit of nitre, which they procured by means of arſenic, and nobody had examined the reſiduum in the retort after diſtillation.

This matter, being worthy of attention, has been reſumed by Mr. Macquer, who has particularly examined the decompoſition of nitre in cloſe veſſels by arſenic, and the new kind of ſalt remaining in the retort after the diſtillation of the nitrous acid.

Theſe reſearches, the detail of which has been given in two memoirs printed in the collection of the academy, diſcovered to him that arſenic, by combining with the baſis of nitre, after having chaſed the acid from it, forms with this alkali a kind of ſalt perfectly neutral, which he has called *neutral arſenical Salt*. *See* SALT (NEUTRAL ARSENICAL).

Another decompoſition of nitre by arſenic was known by chemiſts, and conſequently alſo another combination of arſenic with the baſis of nitre, called by ſome chemiſts, *Arſenic fixed by Nitre*, or *Nitre fixed by Arſenic*; but this latter combination differs from the arſenical ſalt of Mr. Macquer in this, that it is not a neutral ſalt, and that it preſerves, on the contrary, all the properties of an alkali. *See* NITRE FIXED *by* ARSENIC.

Mr. Macquer has alſo made another combination of arſenic with deliquiated fixed alkali. Mention is made of it alſo under the article *Salt (Neutral Arſenical)*. There the differences are ſhewn betwixt theſe two combinations, although formed of the ſame ſubſtances.

White arſenic, although very volatile, is partly fixed by the adheſion which it contracts with different ſorts of earths, and even ſo far as to ſuſtain a vitrifying heat. It facilitates the fuſion of many refractory matters; hence it enters into the compoſition of ſeveral glaſſes, to which it gives much whiteneſs and clearneſs, nearly in the ſame manner as borax and the ſedative ſalt do: but it alſo has the ſame inconvenience, namely, that glaſs, in which a conſiderable portion of arſenic enters, is very quickly corroded by the air.

Dyers employ white arſenic in ſeveral of their operations; but the effects it produces are not yet well known, and require a particular examination. Arſenic and its regulus, being capable of combining with all metals, is employed for ſeveral metallic compoſitions; ſuch, for inſtance, as *white copper*, and *white tombac. See theſe words.*

Arſenic is employed ſucceſsfully for making, together with copper and tin, metallic compounds of a beautiful white color, and of a very denſe and cloſe texture, and conſequently capable of receiving a fine poliſh, of reflecting well the rays of light, and of being formed into metallic mirrors.

From what has been ſaid concerning the properties of arſenic, we may conjecture that this ſubſtance is a metallic earth of a particular nature, intimately combined with a ſaline and even acid principle, which has never been ſeparated from it by any chemical trial, which accompanies it in its combination with phlogiſton when it takes a metallic form, and which adheres to it when, by the burning of this phlogiſton, it becomes again white arſenic.

Thus Becker, without having been acquainted with all the properties of white arſenic, gives an idea of it very analogous to this conjecture. He defines it in his *Subterranean Phyſics*, "a ſubſtance compoſed of the earth of ſulphur "which is in common ſalt," (by which he ſeems to mean the acid of ſea-ſalt) "and of a metal joined to it." In another place, he calls it "a coagulated aqua-fortis." And as he imagined he could trace every where his mercurial earth, or at leaſt ſomething mercurial, he calls mercury a fluid arſenic. He conſiders mercury, and metals precipitated by marine acid, for inſtance, *luna cornea*, as different kinds of artificial arſenic.

Arſenic combines with ſulphur, and forms with it a compound of a yellowiſh tinge, more or leſs red according to the quantity of ſulphur with which it is united. It is of a beautiful yellow color when the ſulphur is only a tenth part of the mixture, and is then called *yellow arſenic:* when the ſulphur is a fifth part of the mixture, it is of a very beautiful red color, and it is then called *red arſenic.* The mixture of ſulphur renders it a little more fixed and more fuſible.

Thus red arſenic may be melted, and by this means acquires tranſparency: it then reſembles a ruby, and has therefore been called *Ruby of ſulphur*, or *arſenical ruby*.

All theſe compounds of arſenic and ſulphur are artificial. They are prepared by mixing and ſubliming theſe two ſubſtances together in the proportions above mentioned, or, ſtill better, in ſubliming together the ſulphur and arſenic of thoſe minerals which contain theſe two ſubſtances.

Natural compounds are alſo found, which are combinations of ſulphur and of arſenic, nearly of the ſame colors as the red and yellow artificial arſenics. They come from the Eaſt, from Tranſylvania, and Turkey. The yellow are called *orpiment*, *orpin*, and *yellow rizigal:* the red are called *ſandarach*, *realgar*, or *red rizigal*.

Agricola, Mathiole, Schrodor, ſeem to have confounded the red and yellow artificial arſenics with the native; and after them moſt chemiſts and naturaliſts have alſo confounded them; a confuſion for which they have been reproached by Hoffman, chiefly becauſe he was convinced that native orpiment and realgars are not poiſonous, like the yellow and red artificial arſenics, from experiments which he had made on purpoſe.

On this ſubject we muſt remark, that, notwithſtanding Hoffman's experiments, which were made only once or twice upon dogs, it would be very imprudent to give the native orpiment or realgars internally: particularly as all chemical trials ſhow that they contain an arſenical principle; and that Hoffman himſelf agrees, that when they have been expoſed to fire, they become very violent poiſons.

Hoffman alſo remarks, that the ancient phyſicians did not ſcruple to give internally orpiment and realgar, and juſtifies them from the reproaches thrown upon them by moderns. But we muſt obſerve, that the ancients were unacquainted with white, red, and yellow arſenics, which have been well known only within theſe two hundred years; and that if they had known the effects of theſe poiſons, and their reſemblance to the native orpiments and realgars, they would probably have been leſs bold. Diſtruſt is as commendable as boldneſs is blameable in thoſe matters, the almoſt inſenſible differences of which may occaſion the moſt troubleſome accidents. For this reaſon, we cannot approve of the ſingular ſecurity with which ſo great a phyſician, as Hoffman was, endeavours to inſpire a confidence for ſo ſuſpicious drugs as native orpiment and realgar.

We do not however mean to ſay, that there is no eſſential difference betwixt native orpiment and yellow arſenic. It is even agreed that the arſenic contained in the orpiment is better united with the ſulphur, and is beſides in a leſs proportion: for one part of orpiment appears to be compoſed of a ſparry ſtone and mica, from which it receives a foliated and ſhining form.

When arſenic is combined with ſulphur, a part of the ſulphur may be ſeparated from it merely by ſublimation, becauſe it is more volatile than arſenic. But ſome of the ſulphur always remains united with the arſenic, from which it cannot be ſeparated but by an intermediate ſubſtance.

Fixed alkali and mercury are two intermediate ſubſtances proper for this operation.

When fixed alkali is uſed, it muſt previouſly be deliquiated or reſolved into a liquid, and with this the ſulphurated arſenic is to be made into a paſte. This paſte is to be ſublimed in a proper veſſel with a heat gradually raiſed. The arſenic then ſublimes in white flowers. When too much alkali is added, leſs arſenic is obtained: becauſe ſome of the arſenic is retained by the part of the alkali which is unſaturated with ſulphur. A liver of ſulphur is found at the bottom of the veſſel after the operation.

When mercury is employed for this ſeparation, it muſt be triturated and mixed with the ſulphurated arſenic, and the mixture ſublimed. Firſt the arſenic riſes, then cinnabar. All the metallic matters which have a ſtronger affinity than mercury to ſulphur may ſeem capable of being employed for this purpoſe; but there are two objections.

1. They have alſo a conſiderable affinity with arſenic, and mercury has none.

2. Arſenic has the remarkable property of taking from all metallic matters, excepting gold, ſilver, and mercury, a part of their phlogiſton; ſo that it would be ſublimed half reguliſed.

In the operation by mercury, a part of the cinnabar frequently riſes with the arſenic; which makes it neceſſary to ſublime it a ſecond time.

Arſenic is ſoluble in all acids, and with them forms combinations which have not yet been ſufficiently examined. The vitriolic acid has the property of rendering it much more fixed than it naturally is: an effect which it alſo produces upon mercury.

If a mixture of arſenic and concentrated vitriolic acid be diſtilled together, a vitriolic acid is obtained, which, as

Mr. Macquer obſerves, has ſometimes the exact ſmell of marine acid. When this ſolution is diſtilled till no more acid riſes, the retort is then almoſt red-hot, and no arſenic is ſublimed; but it remains fuſed at the bottom of the retort; and when it is cold, it is found to be one heavy, compact maſs, brittle and tranſparent as cryſtal-glaſs. This kind of arſenical glaſs expoſed to the air ſoon loſes its luſtre from the moiſture it attracts, which diſſolves and partly deliquiates it. This deliquium is extremely acid.

Arſenic treated with phlogiſton in a proper manner combines with it, and aſſumes all the properties of a very volatile ſemi-metal, of a white ſhining color, more or leſs upon the grey. This ſubſtance is called *Regulus of Arſenic. See this word for the manner of making this regulus, and for its properties.*

The arſenic ſold in commerce is brought chiefly from the cobalt works in Saxony for making *Zaffer*, and *Smalt*. Cobalt contains much arſenic, which muſt be ſeparated from it by a long torrefaction, and which would be loſt but for a particular contrivance for the collecting it.

For this purpoſe, cobalt is roaſted in a vaulted oven, to which is adjuſted a long crooked chimney. The arſenic in vapors paſſes along this chimney, and is there collected; the arſenic which attaches itſelf to the coldeſt and moſt diſtant part of the chimney is in form of a white or grey powder, called *Flowers*, or *Meal of Arſenic*; whereas that part of the arſenic which adheres to the hotteſt part of the chimney, and leaſt remote from the furnace, ſuſtains there a kind of fuſion by which it is reduced into compact, heavy, white maſſes reſembling white enamel. Theſe maſſes of white arſenic are almoſt always interrupted by yellow or greyiſh veins and ſtrata. Theſe colors proceed from a little ſulphur or phlogiſton with which this part of the arſenic is ſtill united.

As arſenic is ſeldom obtained in the great works entirely free from ſulphureous or phlogiſtical particles, if it be required perfectly pure in operations of chemiſtry or of arts, it muſt be again ſublimed after mixing it with ſome intermediate ſubſtance capable of abſorbing its inflammable parts, ſuch as fixed alkali or abſorbent earth.

Arſenic is a very violent corroſive poiſon: it produces always the moſt painful ſymptoms and fatal effects, whether it be taken internally or applied externally. It ought never to be employed medicinally, although ſome people, not very intelligent, give ſmall doſes of it in obſtinate intermittent ſevers, which it effectually cures, but is always attended with bad conſequences to the patients, ſuch as pthiſis, and other no leſs troubleſome diſeaſes.

Perſons poiſoned by arſenic ſuffer acute pains in their bowels, violent vomitings, cold ſweats, ſyncopes, and convulſions, which are always followed by death, unleſs prevented by ſpeedy remedies. The beſt antidotes to this poiſon are large quantities of diluting and ſoftening drinks, as mucilages, oil, milk. Perhaps abſorbent and alkaline matters would alſo produce good effects, from the property which arſenic has of combining with, and in ſome meaſure of being neutralized by, theſe ſubſtances.

When the bodies of perſons killed by arſenic are examined, their ſtomachs and inteſtines are found covered with red, black, livid, inflamed and gangrenous ſpots. Frequently alſo arſenic is found there in ſubſtance, which may eaſily be diſtinguiſhed by its alliaceous ſmell, when put on burning coals, or a red-hot iron.

Mr. Geoffroy's Table does not ſhew the affinities of arſenic. In Mr. Gellert's they are zinc, iron, copper, tin, lead, ſilver, gold, and regulus of antimony. *(h)*

(h) *Neuman* relates that arſenic precipitated almoſt all metallic ſolutions, but moſt of them very ſlowly. Silver, iron, copper, tin, lead, mercury, biſmuth, were precipitated from aqua fortis, and gold from aqua-regia. Solutions of mercury corroſive ſublimate, of copper in aqua regia, of zinc in aqua-fortis, and of regulus of antimony ſuffered no precipitation. Solutions in vitriolic acid of zinc and of iron were precipitated, of copper very little. Sugar of lead, and ſolutions of ſulphur with quicklime or fixed alkali were precipitated. The ſame author further relates, that arſenic was not precipitated from its ſolution in vitriolic or nitrous acids by oil of tartar or by volatile alkali, but it was precipitated from marine acid by oil of tartar.

Arſenic is uſed for many purpoſes ; by dyers, as an ingredient in compoſitions for ſcarlets and other fine reds ; by goldſmiths, for enamelling ; by makers of glaſs, for promoting the fuſion of fritt, and the clearneſs and tranſparency of glaſs ; and in the compoſition for making white opake glaſs, or ſoft enamel ; by potters, for glazing ; by eſſayers, in form of glaſs, for promoting the ſcorification of ores which contain tin and antimony, for the preparation of compound metals, and for whitening copper and braſs. *Neuman* ſays, that a beautiful metal like the fineſt ſteel may be made by melting caſt iron with arſenic, glaſs, and a little tin ; and that a metal reſembling ſilver may be made from iron, tin, arſenic, and perhaps a little copper. Mr. Brandt (*Act. Upſal.*

ASA-FŒTIDA. *(i)*

ASBESTUS. *(k)*

ASHES. This name is generally applied to the ſubſtance remaining of bodies containing an inflammable matter, of which they have been deprived by burning, or calcination in open air. Thus workmen, without underſtanding chemiſtry, and induced merely by analogy or reſemblance, apply the name of *aſhes* to metallic earths thus calcined. Pewterers, for example, give the name *Tin-aſhes*, to the earth of tin which in fuſion has been deprived of its phlogiſton and metallic properties. If workmen had always applied names as properly as they have done this, they could not have been blamed. *See* COMBUSTION.

ASH-HOLE. The aſh-hole is the loweſt part of a furnace, and is intended to receive the aſhes falling from the fire, and to give a paſſage to the air which is to be introduced into the furnace, to keep up the combuſtion. *See* FURNACE.

ATHANOR. Chemiſts have diſtinguiſhed by this name a furnace ſo conſtructed that it can always maintain an equal heat, and which ſhall laſt a long time without addition of freſh fuel.

The body of the athanor has nothing in it particular, and is conſtructed like ordinary furnaces. But at one of its ſides, or its middle, there is an upright hollow tower, which communicates with the fire-place by one or more ſloping openings. This tower ought to have a lid which exactly cloſes its upper opening.

1733) propoſes to make a varniſh for ſhips, of arſenic with pitch, ſulphur, or roſin, to preſerve the timber from rotting, and from worms.

(i) ASA-FOETIDA is a gum-reſin, from four ounces of which rectified ſpirit is capable of extracting two ounces ſix drams and a half of reſinous extract; and water, one ounce three ſcruples and a half of gummy extract. Four ounces of aſa-fœtida, diſtilled either with water or with ſpirit, yield above a dram of eſſential oil, in which its peculiar ſmell reſides. *Neuman.*

(k) ASBESTUS is a grey, greeniſh or blackiſh ſtone, poſſeſſed of the ſame chemical properties as amianthus, and is therefore referable to the ſame claſs of earths. *See* AMIANTHUS. The chief differences betwixt thoſe two ſtones are, that aſbeſtus is heavier than amianthus, and its fibres are more hard and brittle.

Falſe aſbeſtus is a name given to plume-alum. *See* ALUM (PLUME).

When the athanor is to be uſed, as much lighted coal is put in the fire-place as is judged neceſſary, and the tower is filled to the top with unlighted fuel. The tower is then to be exactly cloſed with its lid. As faſt as the coal in the fire-place is conſumed, that in the tower falls down and ſupplies its place. As the coal contained in the tower has no free communication with the external air, it cannot burn till it falls into the fire-place.

The athanor being much celebrated and uſed by ancient chemiſts, it has been particularly deſcribed by many authors, and was formerly found in all laboratories. At preſent this furnace is much leſs employed, and is even neglected. The reaſon of this is, that all the ancient chemiſts were in ſearch of the art of making gold; and being excited by this powerful deſire, and confidence of ſucceſs, they ſpared no trouble nor expence to accompliſh their deſign. They undertook, without heſitation, operations which required great length of time and unremitted heat. Whereas now, theſe alluring hopes having vaniſhed, the cultivators of chemiſtry have no other view than to extend and perfect the theory of this eſſential part of natural philoſophy. This motive, altho' undoubtedly much nobler than the former, ſeems however to be leſs powerful over moſt men. For now, all long and laborious operations whence chemiſtry might receive great advantages, are neglected, as being tireſome and diſguſtful. There is, in fact, a conſiderable difference betwixt the hope of explaining a philoſophical phenomenon, and that of obtaining an ingot of gold capable of producing many others. Hence the inſtruments employed in long operations, and particularly the athanor, are now much neglected; and alſo becauſe the fuel in the tower is apt to ſtick there or fall down at once in too great quantity. The *Lamp-furnace*, which is a true athanor, may be ſucceſsfully employed in operations which do not require much heat. *See* FURNACE (LAMP). *(l)*

AURUM MOSAICUM. *(m)*

AZURE.

(l) See PLATE II. fig. 2. which repreſents an athanor.

(m) AURUM MOSAICUM or MUSIVUM, or MUSICUM, is a chemical preparation conſiſting of beautiful gold-colored flakes. It may may be prepared by the following proceſs. Take of tin twelve ounces, flowers of ſulphur ſeven ounces, of ſal ammoniac ſix ounces, of purified mercury ſix ounces. Melt the tin and add the mercury to it, and when the mixture is cold, powder it, and mix with it the ſal ammoniac and ſulphur. Sublime the mixture

AZURE. The word azure, which at preſent ſignifies in general a fine blue color, was formerly appropriated to *Lapis Lazuli*, called *azure ſtone*, and to the blue prepared from it. But ſince a blue has been extracted from cobalt, cuſtom has applied to it the name of azure, although it differs conſiderably from the former, and is incapable of being uſed for the ſame purpoſes, and particularly for painting in oil. The former at preſent is called *Lapis Lazuli*, or only *lapis*, and the blue prepared from it for painting in oil, is called *Ultramarine*.

The name *azure* is generally applied to the blue glaſs made from the earth of cobalt and vitrifiable matters. This glaſs, which is called *Smalt* when in maſſes, is called azure

a matraſs. The aurum moſaicum will be found under the ſublimate with ſome droſs at the bottom.

Mr. Peter Wolfe has given, in the *Phil. Tranſ. vol.* 61. an explanation of the above proceſs. He ſays, that as ſoon as the mixture grows warm, the tin acts on the ſal ammoniac, and ſets free its volatile alkali, which having a great affinity with ſulphur, joins with a great part of it, riſes in the ſublimation, and is totally diſſipated: That the portion of tin which acted on the ſal ammoniac and ſet free its volatile alkali, unites with the marine acid of the ſal ammoniac, and forms a ſalt of tin which ſublimes: That the mercury, which was added only to divide the tin, unites with ſome of the ſulphur, and ſubliming forms a cinnabar: and laſtly, that the remaining tin unites with the remaining ſulphur, and forms the aurum moſaicum.

According therefore to this explanation, the aurum moſaicum conſiſts only of tin and ſulphur combined together; the uſe of the ſal ammoniac being only to prevent the fuſion of the ſulphur, and the uſe of the mercury being to divide the tin. Accordingly, the ſame ingenious chemiſt ſhews that aurum moſaicum may be prepared without mercury and ſal ammoniac. He alſo obſerves that not only tin, but alſo other metallic ſubſtances may be made to combine by ſimilar proceſſes with a greater quantity of ſulphur than by fuſion. Thus, he found that biſmuth produces a golden-coloured compound, and that iron, copper, lead, and regulus of antimony formed black maſſes.

Aurum moſaicum has no taſte, is unſoluble in water, or by acids, or by liquid alkalis. But by fuſion with fixed alkali, it forms a yellow hepar, ſoluble in water. Aurum moſaicum deflagrates with nitre, as tin itſelf does.

Aurum moſaicum is uſed as a pigment, being of a fine golden colour, and is alſo mixed with melted glaſs to imitate the ſpangles of lapis lazuli; for which latter purpoſe, ſhining talk is alſo employed.

only when it is reduced to a fine powder. Several kinds of azure are diſtinguiſhed, according to its degrees of beauty, by the names of *Fine Azure*, *Powdered Azure*, and *Azure of Four Fires*. In general, the more intenſe the color, and the finer the powder, the more beautiful and dear it is. Azure is employed to color ſtarch; hence it has alſo been called *Starch-Blue*. It is uſed for painting with colors and for a blue enamel. *See* COBALT, SMALT, ZAFFRE. *See alſo* LAPIS LAZULI.

BALANCE (HYDROSTATICAL). The hydroſtatical balance is an inſtrument by which the ſpecific gravity of bodies is determined. For this purpoſe it is neceſſary to find how much any given quantity of a body, whoſe ſpecific gravity is required, loſes of its abſolute gravity when plunged into a fluid. All liquid ſubſtances are proper to determine ſpecific gravities, becauſe theſe gravities are only relative: but water has been generally employed for this purpoſe, becauſe it is the moſt common liquid, and moſt conſtantly of a nearly uniform weight.

When a body is to be weighed in water, it is ſuſpended to one of the arms of a balance, to the other arm of which is fixed an ordinary ſcale, and in this ſcale weights are to be put ſufficient to maintain an equilibrium with the body ſuſpended in air. The weight neceſſary for this purpoſe is to be obſerved and remembered. Then the ſame body ſtill ſuſpended at the arm of the balance, and counterpoiſed by the weights in the ſcale, is to be immerſed in water, by which the equilibrium is deſtroyed, and the balance inclines to the ſide of the weights. The weights are therefore to be diminiſhed till an equilibrium is reſtored with the body ſunk entirely in water. The difference betwixt the weights of the ſame body weighed in air and in water, determines its ſpecific gravity.

It is proper to obſerve upon this ſubject, 1. That water can determine the ſpecific gravity of bodies only which are ſpecifically heavier than itſelf. For it is certain, that if they were lighter than water they could not ſink in it by their own weight, which is neceſſary for the experiment. In this caſe it is neceſſary to employ ſome liquid lighter than water, ſuch as ethereal oils, ſpirit of wine, or ether.

2. It is proper to remark on the ſubject of the hydroſtatical balance, that it can be employed conveniently for

ſolid bodies only, becauſe the fluids cannot be weighed in water but by means of ſome veſſel which muſt be immerſed along with them. But this veſſel having its peculiar ſpecific gravity would render a troubleſome calculation neceſſary. Another method is then generally uſed to determine the ſpecific gravity of liquids.

3. If the ſolid body, whoſe ſpecific gravity is to be determined, be ſoluble in water, as, for inſtance, a lump of ſalt, water could not be employed for this experiment, becauſe a quantity of it would be diſſolved during the time of weighing; by which an error would be occcaſioned ſo much greater as there was more of the ſoluble body diſſolved. In this caſe then it is neceſſary to uſe ſome other liquid which cannot diſſolve the body, or elſe not to employ the hydroſtatical balance, but the ſame method by which the ſpecific gravity of liquids is diſcovered. *See* GRAVITY, GRAVITY (ABSOLUTE), GRAVITY (SPECIFIC).

BALLS (MARTIAL). Martial Balls are a mixture of filings of iron and of cream of tartar formed into a ſolid conſiſtence and form of a ball, which is uſed to impregnate water or other liquids with iron diſſolved by the tartareous acid. To make theſe balls, one part of filings of iron and two parts powdered cream of tartar are mixed well together, and put into an earthen or iron veſſel with ſome water. This mixture is to be ſtirred from time to time, till it becomes almoſt dry, and then it is to receive more water, and to be ſtirred as before. This treatment is to be continued till it acquires, when nearly dry, ſomewhat of the conſiſtence and tenacity of ſoftened roſin. Then it is to be rolled up into the form of a ball, which is generally kept tyed up in a rag, and when intended to be uſed, it is to be infuſed in water, till it gives ſome color to that liquid.

The infuſion of martial balls is tonic, vulnerary, diſcutient, and aperitive; and is employed both internally and externally. *See* IRON.

Iron being ſoluble in all acids, is attacked in this preparation by the tartareous acid, which reduces it to a kind of neutral ſalt not cryſtallizable. This ſalt would remain liquid, and would form a *ſoluble martial tartar*, called *Tartariſed Tincture of Mars*. If proper proportions of filings of iron and cream of tartar be uſed, and treated long enough for an entire and complete combination, nothing would be obtained but a liquor or *magma*, which could not be preſerved in a ſolid form, but would be continually moiſt. Therefore in the martial ball there is a good deal of the cream of tartar and filings of iron not combined together, by which its ſolidity is preſerved.

Hence it follows that the infuſion of the martial ball is entirely of the ſame nature as the tartariſed tincture of Mars; and therefore theſe preparations may be ſubſtituted for each other. *See* TINCTURE *of* MARS (TARTARISED).

BALLS (MERCURIAL). Mercurial balls are an amalgam of mercury and tin, ſufficiently ſolid to be moulded, and to preſerve a given form.

The method of making them is by adding mercury to melted tin, and pouring the fluid maſs into a round and hollow mould.

Theſe balls are employed to purify water, in which they are boiled; for which purpoſe travellers often carry ſome along with them.

BALLOON. This name is given to glaſs bottles, or receivers, which are generally round like hollow ſpheres, or like foot-balls, called in French, *Balons*, whence they are named.

In a laboratory there ought to be balloons of different ſizes, capable of containing from a quart of water to fifteen or twenty pints. The large balloons are employed in diſtillations in great, being capable of containing much, and having necks wide enough to admit thoſe of large retorts. For the contrary reaſons, ſmall balloons are employed when a little matter is to be diſtilled.

Large balloons are alſo neceſſary when the vapors diſengaged during the diſtillation are very elaſtic and difficult to be condenſed; becauſe ſuch vapors would not find in ſmall veſſels ſufficient ſpace to circulate and condenſe; hence they would either burſt the veſſel, or if a vent was given them to prevent that accident, they would be entirely diſſipated and loſt. Notwithſtanding the ſize of the balloons employed, ſo much air is diſengaged during the diſtillation of certain hard bodies, vegetable and animal, ſuch as wood, tartar, hartſhorn, &c. and the vapors of certain acids, ſuch as the ſmoking ſpirits of nitre and of ſea-ſalt, are ſo elaſtic and expanſible, that a ſmall hole in the ſide of the balloon is frequently neceſſary to to give vent to thoſe vapors: Afterwards this hole, which ought to be about half a line in diameter, is to be cloſed with a peg of wood, or ſome lute.

It is to be wiſhed, that in the glaſs-houſes where chemical veſſels are made, it was the cuſtom always to make ſuch holes in the balloons; which might eaſily be done by a pointed inſtrument, while the glaſs is ſtill hot and ſoft. Inſtead of this practice, chemiſts are themſelves obliged to drill holes through the baloons with conſiderable difficulty and hazard of breaking. This operation is performed in the following manner.

The moſt convenient part for drilling this hole is nearer the neck than the bottom of the balloon, and for this purpoſe one of thoſe bubbles which are always found in glaſs is choſen.

This bubble is firſt of all cut or broke by the pointed angle of a flint, and afterwards the hole is to be completed by turning this pointed flint always in the ſame place. Mr. Beaumé obſerves, that when an entry is once made by the flint, the hole may be better finiſhed by a triangular drill with a ſtrong hard tempered ſteel point, becauſe the angular points of the flint are continually breaking, by which the operation is prolonged. *(n)*

For certain operations balloons with two necks placed oppoſite to each other are uſed. One of theſe ought to be large enough to receive the neck of the retort, and the other to enter the neck of a ſecond balloon. Theſe two joinings muſt be well luted together. *See* LUTE.

This apparatus is called *Enfiladed Balloons*. Their uſe is to encreaſe the whole ſpace of the receiver, becauſe any number of theſe may be adjuſted to each other; and as they communicate with each other, their capacity is ſo much larger as their number is greater. But good artiſts ſeldom uſe ſo troubleſome an apparatus. The only one of theſe veſſels which is generally uſed, is a ſmall oblong balloon with two necks, which is to be luted to the retort and to the great balloon. It ſerves to remove this receiver from the body of the furnace, and to hinder it from being expoſed to too great heat. This ſmall balloon with two necks is called an *Adopter*. As this adopter is larger in its middle than at either extremity, it ſerves alſo to receive ſolid bodies, and to prevent them from paſſing with the liquids into the great balloon. It is chiefly in diſtillations of volatile concrete ſalts that the adopter ſerves for this laſt purpoſe. *See* DISTILLATION *and* RECEIVER.

BALSAM. By balſams are meant oily, odoriferous, and aromatic matters, liquid, but ſomewhat thick, which

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(n) Pierced balloons, receivers and retorts are commonly made in Engliſh glaſs-houſes. But as chemiſts may have occaſion to drill holes through glaſs veſſels, it may be proper to obſerve, that this operation may be beſt performed with a copper drill and emery, as a ſteel inſtrument occaſions vibrations apt to break the glaſs.

flow ſpontaneouſly from certain trees, or from inciſions made on purpoſe to obtain a larger quantity.

Theſe balſams, which may more particularly be called *natural balſams*, to diſtinguiſh them from ſome compoſitions alſo called balſams, derive their liquidity and ſmell from a greater or leſs quantity of eſſential oil which they contain, and which may be extracted by diſtillation with the heat of boiling water. *See* OILS (ESSENTIAL).

Balſams may be even conſidered as true eſſential oils, which have loſt ſome of their odoriferous principle, and of their fineſt and moſt volatile part. When they are deprived of their remaining part of volatile oil, their reſiduums exactly reſemble thoſe which remain after the rectification of eſſential oils. Theſe reſiduums are true reſins, from the analyſis of which the ſame principles are obtained as from natural reſins; and theſe laſt are nothing but balſams exhauſted by time, or by the action of the air, and of the ſun, of all their odoriferous and volatile parts.

There are ſeveral kinds of natural balſams. They do not eſſentially differ from each other, but only in the ſmell and degrees of conſiſtence. The ſame kind of balſam alſo frequently differs with reſpect to the degrees of theſe two qualities.

The principal natural balſams are the *balſam of Mecca*, or the *white balſam*, which is the moſt rare and dear of all; the *balſam of Tolu* and of *Peru in ſhells*, both which Mr. Beaumé conſiders as the ſame kind of balſam, with this difference, that the firſt is liquid, and the ſecond is almoſt dry; the *balſam of Copahu*, or of *Copaiba*, vulgarly *Capivi*; *liquid ſtyrax*, or *ſtorax*; and *turpentines*. *See for an example of the analyſis and properties of all theſe balſams the word* TURPENTINE.

BALSAM *of* SULPHUR. The balſam of ſulphur is a ſolution of ſulphur in oil.

Sulphur, from the quantity of phlogiſton it contains, is inſoluble in water and aqueous liquors: but it is capable of diſſolving in oils, which alſo contain much phlogiſton.

All oils, either expreſſed or eſſential, can diſſolve ſulphur: to make this ſolution, the oil ought to be poured on the ſulphur in a matraſs placed in a ſand-bath, and ſufficient heat applied to melt the ſulphur, according to Mr. Beaumé's obſervation, who kept theſe two ſubſtances a very long time together in a leſs heat, without perceiving any ſign of ſolution.

While the oil is diſſolving the ſulphur, it acquires a reddiſh or brown color, an acrid and diſagreeable taſte, and a ſtrong fetid ſmell like that of the combination of oil with vitriolic acid.

As water can diſſolve only a determinate quantity of ſome ſalts, and as this quantity is greater when the water is warm than when cold, ſo alſo oils can diſſolve only a determinate quantity of ſulphur, and this quantity is greater when heat is applied: hence it happens, that when an oil is ſaturated with ſulphur, by a ſuitable heat; a part of the ſulphur thus diſſolved ſeparates from the oil, when the ſolution cools, and coagulates at the bottom of the veſſel in a cryſtallized form, in the ſame manner as ſome ſalts do, which having been diſſolved in boiling water, cryſtallize on the application of cold.

The portion of ſulphur remaining diſſolved in oil is in a ſingular ſtate; the adheſion of its conſtituent parts, namely, the vitriolic acid and phlogiſton, ſeems to be much diminiſhed by the union they contract with the principles of the oil. Its vitriolic acid unites with the watery part of this oil; and thus theſe two principles have no longer the neceſſary relation to each other for the formation of ſulphur. *See* SULPHUR.

It is certain at leaſt, that all theſe changes happen when the balſam of ſulphur is diſtilled. This is proved by the analyſis which Homberg made of this combination: for by diſtilling it with a very ſlow fire, he obtained a volatile ſulphureous acid, a vitriolic acid more or leſs ſtrong and ſulphureous, ſome oil, partly fluid and partly thick, and a charry reſiduum, but no ſulphur. This is a proof that the ſulphur was decompoſed in the experiment, as all the ſame products are obtained from a combination of vitriolic acid with oil, when the oil is in too great quantity relatively to the acid.

The balſams of ſulphur are named from the particular oils which enter into their compoſition. Thus if a balſam of ſulphur be made with the eſſential oil of turpentine, it is called *terebinthinated balſam of ſulphur*; if it be made with the eſſential oil of aniſeed, it is called the *balſam of ſulphur with oil of aniſeed*. Theſe are the two moſt uſed. The balſam of ſulphur made with oil of nuts is called *Rulland's balſam of ſulphur*. *See* SULPHUR.

BASALTES. *(o)*

(o) BASALTES is a heavy, hard ſtone, chiefly black or green, conſiſting of priſmatic cryſtals, the number of the ſides of which

BASIS, *or* BASE. Any body which is diſſolved by another body, which it receives and fixes, and with which it forms a compound, may be called the baſis of that compound. Thus, for example, the baſes of neutral ſalts are the alkaline, earthy, and metallic matters which are ſaturated by the ſeveral acids, and form with them theſe neutral ſalts. In this ſenſe it is that theſe neutral ſalts are called *ſalts with earthy baſes*, *ſalts with alkaline baſes*, *ſalts with metallic baſes*; alſo the appellations, *baſis of alum*, *baſis of nitre*, *baſis of Glauber's ſalt*, *baſis of vitriol*, &c. ſignify the *argillaceous earth*, which, with the vitriolic acid, forms alum; the *vegetable alkali*, which, with the nitrous acid, forms nitre; the *mineral alkali*, which, with the vitriolic acid, forms Glauber's ſalt; and the *metal*, which, with the vitriolic acid, forms a vitriol: becauſe theſe ſubſtances are ſuppoſed to be fixed, unactive, and only yielding to the action of the acids, which they fix, and to which they give a body and conſiſtence.

It is proper, for the conveniency of chemical language, to retain theſe expreſſions: but theſe baſes muſt not be conſidered as really unactive; for in every combination and ſolution the ſeveral bodies which unite are equally active, their action being reciprocal. They diſſolve each other; ſo that it is as proper to ſay, as Mr. Gellert obſerves, that a metal or an earth diſſolves an acid, as that an acid diſſolves a metal or an earth; although this latter mode of expreſſion be more general. It is even probable that the diſſolving power which the more weighty and fixed bodies have is really much ſtronger than that of bodies leſs weighty and fixed. This is certainly ſo if the tendency to unite be only an effect of the general attraction or gravitation of all the particles of matter to each other. *See* COMBINATION *and* SOLUTION.

BATH. Chemiſts call ſeveral matters which they employ to tranſmit heat, *Baths*. The matters moſt frequently uſed for this purpoſe are water and ſand.

is uncertain. It is called by Engliſh mineralogiſts *cockle*, and by Germans *ſchorl*. Its ſpecific gravity is to that of water, as 3000 or upwards to 1000. It is conſidered by Wallerius as a ſpecies of the *corneus*, or *horn-rock*. Cronſtedt enumerates it among the earths which he called *Garnet earths*. Baſaltes frequently contains iron, and conſiſts either of particles of an indeterminate figure, or of a ſparry, ſtriated, or fibrous texture. Black baſaltes is called *Lapis Lydius*, and is uſed as a touchſtone to ſhew the colors of metals. Baſaltes has a flinty hardneſs, is inſoluble by acids, and is fuſible by fire. *See* GARNET.

When water is employed it is called *Balneum Mariæ*, or *water-bath*. The water-bath is much uſed, and is convenient for many operations.

As water, when expoſed to fire in any veſſel from which it can evaporate, does only receive a determinate degree of heat, which always remains the ſame, when once it has arrived to the boiling heat, it follows, that by the water-bath a degree of heat always equal may with certainty be tranſmitted. Further, this degree of heat being incapabable of burning, or of communicating an empyreumatic quality to matters ſuſceptible of it, the water-bath has alſo the advantage of not expoſing ſubſtances to this inconvenience. The water-bath may likewiſe be employed ſucceſsfully for all degrees of heat inferior to that of boiling water. *See* ALEMBIC, *for the ſtructure of the water-bath.*

When veſſels in which diſtillations and digeſtions are made, are placed in ſand, then a *ſand-bath* is formed. This intermediate ſubſtance is alſo very convenient to moderate the too great activity of the naked fire, and to tranſmit any degree of heat from the weakeſt to a red heat. As this bath is attended with leſs trouble, and requires leſs apparatus than the water-bath, it is much uſed in laboratories. For the ſand-bath nothing is requiſite but an earthen or iron veſſel filled with fine ſand. This veſſel is fitted in to a furnace, and is capable of containing the cucurbits, retorts, matraſſes, or other veſſels containing the matter to be operated upon.

The only baths now generally uſed in chemiſtry are thoſe mentioned, the water and ſand-baths, becauſe they are the moſt convenient, and are ſufficient for all the operations which do not require a naked fire.

Ancient chemiſts, who had all a tincture, more or leſs, of alchemy, and who for that reaſon were much more careful and laborious in their operations, uſed many different baths, in order to apply preciſely the required degree of heat. They uſed the vapor of water, aſhes, dung, the ſubſtance remaining after the ſqueezing of grapes, and whatever they imagined moſt proper for their purpoſes: hence the names of *vapor-bath*, *aſh-bath*, *dung-bath*, *bath of a horſe's belly*, &c. But, as we have ſaid, an intelligent and experienced artiſt may very well perform all the chemical operations, which do not require a naked fire, by means of the water and ſand-baths. *See* DISTILLATION *and* DIGESTION.

The word *bath* is alſo uſed in another ſenſe to ſignify the fuſion of metallic matters in certain operations: thus, for example, in refining or cupelling, the metals are ſaid to be *in bath*, when they are melted. When gold is purified by antimony, this ſemi-metal melted is called by ſome chemiſts the *bath of gold*. Alchemiſts, who conſider gold as the king of metals, call antimony *the bath of the king only*, *balneum ſolius regis*; becauſe, in fact, gold only can reſiſt the action of antimony. *See* PURIFICATION *of* GOLD *by* ANTIMONY.

BDELLIUM. *(p)*

BEE-GLUE. *(q)*

BEER. Beer is a ſpirituous liquor made from any farinaceous grain, but generally from barley. It is, properly ſpeaking, the wine of barley. The meals of any of theſe grains being digeſted with a ſufficient quantity of water to extract their juices, and remaining at reſt in a degree of heat requiſite for the ſpirituous fermentation, naturally undergo this fermentation, and are changed into a vinous liquor. But as all theſe matters render the water mucilaginous, fermentation proceeds ſlowly and imperfectly in theſe liquors. On the other ſide, if the quantity of farinaceous matter be ſo diminiſhed that its extract or decoction may have a convenient degree of fluidity, this liquor will be impregnated with ſo ſmall a quantity of fermentable matter, that the beer or wine of the grain will be too weak, and have too little taſte.

Theſe inconveniences are remedied by preliminary operations which the grain is made to undergo.

Theſe preparations conſiſt in ſteeping it in cold water that it may ſoak and ſwell to a certain degree, and in laying it in a heap with a ſuitable degree of heat, by means of which, and of the imbibed moiſture, a germination begins, which is to be ſtopped by a quick drying, as ſoon as the bud ſhews itſelf. To accelerate this drying, and render it more compleat, the grain is ſlightly roaſted, by making it paſs down an inclined canal ſufficiently heated.

(p) BDELLIUM is a gum reſin, from an ounce of which may be extracted by water ſix drams and two ſcruples, or by ſpirit two drams. *Neuman.*

(q) BEE-GLUE is a ſoft, unctuous, glutinous matter employed by bees to cement the combs to the hives, and to cloſe up the cells. *Neuman.*

This germination, and this ſlight roaſting, changes conſiderably the nature of the mucilaginous-fermentable matter of the grain. The germination attenuates much, and in ſome meaſure totally deſtroys the viſcoſity of the mucilage; and it does this, when not carried too far, without depriving the grain of any of its diſpoſition to ferment. On the contrary, it changes the grain into a ſaccharine ſubſtance, as may be perceived by maſhing grains beginning to germinate. The ſlight roaſting contributes alſo to attenuate the mucilaginous fermentable matter of the grain. When the grain is thus prepared, it is fit to be ground, and to impregnate water with much of its ſubſtance without forming a glue, or viſcous maſs. The grain thus prepared is called *malt*. This malt is then to be ground; and all its ſubſtance, which is fermentable and ſoluble in water, is to be extracted by means of hot water. This extract or infuſion is ſufficiently evaporated by boiling in caldrons; and ſome plant of an agreeable bitterneſs, ſuch as hops, is at that time added, to heighten the taſte of the beer, and to render it capable of being longer preſerved. Laſtly, this liquor is put into caſks, and allowed to ferment; nature performs the reſt of the work, and is only to be aſſiſted by the other moſt favourable circumſtances for the ſpirituous fermentation. *See* FERMENTATION (SPIRITUOUS).

BEN. *(r)*

BENJAMIN. *Benjamin*, or *Benzoin*, is a reſin of an agreeable aromatic ſmell, from which an eſſential ſalt, or volatile, concrete, cryſtallized acid, called *flowers of Benjamin*, is obtained by ſublimation. *See* FLOWERS *of* BENJAMIN.

(r) BEN-NUTS yield, by expreſſion, much oil, which, from its property of not becoming rancid, at leaſt for years, is uſed as a menſtruum for the extraction of the odoriferous part of flowers of jaſmin, violets, roſes, hyacinths, lillies of the valley, tuberoſes, jonquils, clove-gilly flowers, and others, which, like theſe, yield little or no eſſential oil by diſtillation, but impart their fragrance to expreſſed oils. The method of impregnating oil of ben with the odor of flowers is this: Some fine carded cotton is dipt in the oil, and put in the bottom of a proper veſſel. On this is ſpread a thick layer of freſh flowers, above which more cotton dipt in oil is placed; and thus alternately flowers and cotton are diſpoſed, till the veſſel (which may be made of tin, with a cover to be ſcrewed on to it, or of porcelain) is full. By digeſtion during 24 hours in a water-bath, the oil will receive the odor of the flowers.

JAMIN. As to its other principles, it is ſimilar to other reſins. *See* RESIN.

BERYL. (s)

BEZOAR MINERAL. Bezoar mineral is the earth of the regulus of antimony deprived of all its phlogiſton by the action of the nitrous acid and by calcination.

The ordinary proceſs to make this preparation conſiſts in diſſolving butter of antimony in a ſufficient quantity of nitrous acid, or till the phenomena of ſolution ceaſe. If more nitrous acid be added than is neceſſary for the ſolution, no inconvenience follows, as we ſhall preſently ſee.

When the ſolution of butter of antimony is made, it is to be evaporated to dryneſs in a glaſs or ſtone-ware veſſel: more nitrous acid is then to be poured upon it; rather too much than too little; becauſe an exceſs of this does no harm: this ſolution is to be evaporated, as at firſt; and the ſame operation is to be repeated a third time; after which the matter being dryed, is to be calcined for half an hour, till, according to Lemery, a very ſlight acidity only remains.

This operation, which was invented for the preparation of a remedy, furniſhes phenomena very worthy of attention, and fit to illuſtrate the eſſential properties of the nitrous and marine acids. The following remarks then are to be made on this ſubject: Aqua-regia being the moſt active menſtruum of regulus of antimony; and ſpirit of nitre, in which the butter of antimony is diſſolved, forming an aqua-regia with the marine acid contained in this butter; a new ſolution is made of the reguline part, which after this operation is no longer united with the marine acid only, but with the nitrous and marine acids jointly, that is, with aqua-regia. When this ſolution is not hurried too much, it is clear and limpid; and this is the beſt method of having the greateſt poſſible quantity of regulus of antimony perfectly diſſolved by aqua-regia.

As upon this occaſion, the nitrous acid finds the integrant parts of the regulus of antimony ſeparated from each other by the interpoſition of the parts of the marine acid, and conſequently the aggregation of the regulus of antimony broken, this nitrous acid ſeizes upon all the parts of the regulus with ſo much more facility and almoſt inſtantaneouſly: hence it happens that unleſs the nitrous acid be gradually added, and at long intervals, the ſolution is made ſo impetuouſly, that all the matter is apt to riſe inſtantly over the containing veſſel with effervеſcence, which happens in moſt ſolutions, and which proceeds from diſengaged air. The quantity of air in this ſolution is very great. Dr. Hales has aſcertained that thirty-ſix cubic inches of air are diſengaged from the ſolution of half a cubic inch of butter of antimony in as much nitrous acid: but this muſt vary according to the manner of making the ſolution. Is it even certain that it is air which is thus diſengaged, and not ſome other ſubſtance reduced to elaſtic vapor?

(s) BERYL, or AQUA MARINA, is a polygonous pellucid gem, the tenth from a diamond in hardneſs, of a ſea-green color, and fuſible by fire. This gem may be imitated, by adding to twenty pounds of cryſtal-glaſs, made without magneſia, ſix ounces of calcined braſs or copper, and a quarter of an ounce of prepared zaffre.

However it be, the new combination of regulus of antimony with the acids of aqua-regia is very different from the butter of antimony. The preſence of the nitrous acid produces an entire change. This metallic ſubſtance is no longer united with a ſingle acid, incapable of depriving it of its phlogiſton, and which, by its intimate union, communicates to the ſemi-metal its volatility. The nitrous acid cannot unite with the regulus of antimony without depriving it of a large portion of its inflammable principle. The regulus thus half calcined can no longer have the ſame adheſion to the marine acid; therefore if this new combination be expoſed to the action of fire, the marine acid, which now ſcarcely adheres to this altered metallic matter, far from raiſing it, as when it was combined with no other acid, does with great facility evaporate; and the nitrous acid, which adheres ſtill leſs than the marine acid to this metallic earth, quits it ſtill more eaſily, and continues to deprive it more and more of its inflammable principle.

The ſame effects ought to take place ſtill more upon the new additions and evaporations of the nitrous acid; therefore, after all theſe operations, nothing remains but an earthy white matter, abſolutely fixed, unfuſible, and inſoluble in acids, which has no longer any emetic or purgative qualities, nor any taſte, if ſufficiently calcined. It is, in ſhort, a true calx of antimony, entirely ſimilar to diaphoretic antimony, except that to this latter preparation a ſmall portion of the earth of the alkaline baſis of nitre adheres, which is not to be found in bezoar mineral: hence we ought to conclude, that nitrous acid produces the ſame effects upon the regulus of antimony by the humid, as it does by the dry way.

When bezoar mineral is prepared for the purpoſes of medicine, it is proper not to calcine it too much; otherwiſe it would probably have no virtue. When it is moderately calcined, as Lemery preſcribes, it may have the ſudorific virtue aſcribed to it, from the ſmall quantity of acid and perhaps of phlogiſton adhering to it. It is this ſudorific virtue, truly or falſely aſcribed, which has occaſioned the name of bezoar mineral, becauſe the animal bezoar is conſidered alſo as a ſudorific.

It is evident from what has been ſaid concerning the nature of the bezoar mineral, and what paſſes during its preparation, that the marine acid contained in the butter of antimony is entirely loſt, and not eſſential to the operation, ſince the nitrous acid alone is capable of depriving the regulus of antimony of all its phlogiſton, and of reducing it to a white calx entirely ſimilar to bezoar mineral. Inſtead then of employing butter of antimony, which requires a preliminary and expenſive preparation, the nitrous acid may be directly poured upon the powdered regulus, and its action aſſiſted by heat. This acid readily corrodes the ſemi-metal, without diſſolving it; becauſe it deprives it of its phlogiſton while it attacks it, and quickly reduces it to a white calx.

When this acid is carried off, and more acid poured on, and this operation repeated ſeveral times, till the matter is at laſt calcined, a white calx of antimony is obtained entirely ſimilar to bezoar mineral.

BISMUTH. Biſmuth, called alſo *tin-glaſs*, and by ſome naturaliſts *marcaſita officinarum*, is a ſemi-metal ſomewhat ſimilar to the regulus of antimony. It appears to be compoſed of cubes formed by the application of plates upon each other. Its color is leſs white than that of the regulus of antimony, and it has a reddiſh tinge, particularly when it has been expoſed to the air.

It is the heavieſt of the ſemi-metals, and loſes in water about a ninth part of its weight.

It is alſo very fuſible, and melts a long time before it is red-hot.

Biſmuth is ſemi-volatile, like the other ſemi-metals. When expoſed to the fire, flowers riſe from it; it is calcined; and converted into a litharge and glaſs nearly as lead is. It may even be employed, like that metal, for the purification of gold and ſilver by cupellation.

It eaſily combines with ſulphur, and is thereby reduced into a ſtriated mineral like antimony.

It amalgamates with mercury, and, according to Mr. Wallerius, it has the ſingular property of ſo attenuating tin, ſilver, and eſpecially lead, when any of theſe metals are added to this amalgam, that a part of them paſſes along with the mercury through chamois leather. This ſufficiently proves that this method of purifying mercury is inſufficient. *(Wallerius's Mineralogy)*.

Mr. Cramer, on the contrary, ſays that only lead, and not the other metals, can be ſo diſpoſed by biſmuth as to paſs along with the mercury. He adds, that the lead muſt be previouſly united by fuſion with the biſmuth; and that if the amalgam be digeſted during ſome days, the biſmuth is ſeparated, and the lead is left attenuated with the mercury.

This ſemi-metal is not equally ſoluble in the ſeveral acids.

The vitriolic acid does not, properly ſpeaking, diſſolve biſmuth. If a part and a half of biſmuth be mixed with one part of concentrated vitriolic acid, the whole diſtilled to dryneſs, and the reſiduum waſhed with water, the liquor drawn off is of a red yellow color, but from which nothing can be precipitated by alkalis: hence it may be ſuſpected that the vitriolic acid attacks only the inflammable part of biſmuth, and does not diſſolve its metallic earth.

The nitrous acid diſſolves biſmuth very well.

The marine acid attacks and diſſolves biſmuth a little, but ſlowly and difficultly. Alkalis form a precipitate with marine acid in which biſmuth has been digeſted a certain time.

This ſemi-metal does not very ſenſibly detonate with nitre. It is, neverthele‍ſs, calcined by this ſalt, as all the imperfect metals and ſemi-metals are.

Two parts of nitrous acid diſſolve with heat and effervescence one part of biſmuth. The ſolution is clear, limpid, and roſe colored. It coagulates into ſmall cryſtals as ſoon as it cools.

This ſolution ought to be made gradually, to avoid too great commotion and efferveſcence.

Water alone being added to this ſolution, precipitates the biſmuth. The precipitate is of a very beautiful white, and is commonly called *magiſtery of biſmuth*, and by ſome artiſts *Spaniſh white*, being the ſame which is uſed as a paint for the ſkin.

To have this white very beautiful, an aqua-fortis muſt not be emyloyed, which is adulterated by a mixture of vitriolic acid; for this latter acid gives it a greyiſh caſt.

If the nitrous acid has diſſolved but little biſmuth, much more water is neceſſary to effect a precipitation.

This magiſtery ought to be well waſhed, to deprive it as much as poſſible of the adhering acid, and preſerved in a well cloſed bottle; becauſe this ſemi-metal, when thus divided, has, like ſilver and lead, the property of eaſily combining with phlogiſton in vapor, and of becoming black by that addition: hence the ſkin of women painted with this white may be rendered quite black by the phlogiſtic vapors which riſe from putrefying matters, neceſſary-houſes, ſulphur, liver of ſulphur, bruiſed garlic, &c.

Alkalis alſo added to the ſolution of biſmuth occaſion a white precipitate of this ſemi-metal, but not ſo beautiful as when water only is uſed; becauſe the pureſt alkalis contain ſome phlogiſton, which gives more or leſs color to the precipitate.

Several chemiſts, amongſt whom is Mr. Pott, have believed that the ſolution of biſmuth, which when well ſaturated may be precipitated by water, could not be precipitated by means of the marine acid, as thoſe of lead and ſilver may, and conſequently that a corneous biſmuth cannot be obtained. But Mr. Rouelle in his memoir upon ſalts, printed amongſt the memoirs of the academy for the year 1754, ſays, that after having precipitated from a well ſaturated ſolution all the biſmuth that he could by means of water, he obtained a new precipitate by adding to the remaining liquor an equal quantity of ſaturated ſolution of ſea-ſalt, and by gradually mixing with theſe a quantity of common water equal to four times the quantity of the two ſolutions. This ſecond precipitate is conſidered by Mr. Rouelle as a corneous biſmuth.

If this be the caſe, biſmuth reſembles lead in many of its properties, as Mr. Geoffroy the younger has ſhewn in the memoirs of the academy. Accordingly ſome chemiſts have called biſmuth, the *lead of the ſemi-metals*.

Lemeri ſays, that if the ſolution of biſmuth be uſed to write with as an ink, that the writing does not appear, but that it becomes very black, when moiſtened with the deliquiated liquor of the ſcoria of regulus of antimony. This ſolution is therefore a ſympathetic ink. The reaſon of this phenomenon is founded on what we have obſerved concerning the property which biſmuth has, when much divided, of eaſily imbibing a ſuperabundant quantity of phlogiſton, and by that means of acquiring a black color.

The ſcoria of regulus of antimony is almoſt entirely liver of ſulphur. The alkali of this liver precipitates the biſmuth from the ſolution employed to write with; and the ſulphur or phlogiſton, diſengaged from the liver, blackens the biſmuth, which therefore becomes viſible.

It is evident after this explanation, that it is needleſs to have recourſe to the ſolution of ſcoria of regulus of antimony in this experiment; for it only acts as a liver of ſulphur; and the portion of regulus of antimony contained in this ſcoria contributes nothing to the ſucceſs: the liver of ſulphur alone may therefore be as well employed.

Biſmuth readily unites with all metallic matters, excepting, according to Mr. Gellert, zinc and arſenic; and all the allays are rendered more fuſible by biſmuth. This chemiſt places the affinities of metallic matters with biſmuth in the following order: iron, copper, tin, lead, ſilver, and gold. (*t*)

(*t*) 1. Biſmuth, like iron, is ſaid to *occupy, when fuſed, a leſs ſpace than when ſolid.* 2. It is *fuſible* with a heat of 460° of Fahrenheit's thermometer. 3. It greatly *encreaſes the fuſibility of ſome other metals.* Thus, an allay conſiſting of equal parts of tin and biſmuth is fuſible with a heat of 280° of Fahrenheit's ſcale. 4. Equal parts of *gold* and *biſmuth* form a brittle regulus colored like biſmuth. Equal parts of *biſmuth* and *ſilver* form a maſs not ſo brittle as the former. A ſmall portion of biſmuth encreaſes the brightneſs, hardneſs, and ſonorouſneſs of *tin.* The color of *copper* is rendered leſs red, but not white, by biſmuth. Equal parts of *biſmuth* and *lead* form a dark grey compound. Biſmuth may be united with *iron* by a ſtrong heat. It does not unite with *zinc* or with *regulus of cobalt,* or only in a ſmall proportion. 5. The *uſes* of biſmuth are, for making *pewter* with tin; for *ſoldering* ſome metals; for *printers types* (Homberg adviſes one part of biſmuth and one of tin to be added to twelve parts of the common compoſition, which is one part of copper, one part of regulus of antimony, and five parts of lead); for *foils for mirrors,* the common mixture for this being one part of tin, one part of lead, two parts of biſmuth, and ten parts of mercury; for *anatomical injections,* equal parts of lead, tin, and biſmuth, to which ſome add a little mercury, forming a mixture ſufficiently fuſible; for *imitating ſilvering on wood,* for which purpoſe it is ground, applied with whites of eggs, and burniſhed; for *purifying gold and ſilver by cupellation,* for which it is preferable to lead, as it more effectually deſtroys imperfect metals, promotes the vitrification of

BISTRE. (u)

BITTERN. (w)

BITUMEN. Bitumens are oily matters, of a ſtrong ſmell, and of different conſiſtences, which are found in many places within the earth.

There is only one liquid bitumen known: it is called *petroleum*, becauſe it is an oil which actually flows from clefts in certain rocks, and it is gathered in wells dug in certain grounds and mountains. *See* PETROLEUM.

Solid bitumens are *Amber*, called alſo *Karubé*, or *yellow amber*; *Jet*; *Aſphaltum*, or *bitumen of Judea*; and foſſil or *pit-coal*.

All theſe bitumens, when diſtilled, furniſh phlegm, an acid liquor frequently ſulphureous, a thin oil like petroleum, a volatile acid and concrete ſalt, (of which amber gives the largeſt quantity) a black and thick oil, and laſtly, a charry reſiduum, more or leſs earthy and copious, according to the nature of the particular bitumen analyſed. Foſſil coal furniſhes the largeſt quantity of this reſiduum. From this analyſis it appears, that bitumens are compoſed, like all other vegetable and animal concrete oily matters, of an oil and an acid. They differ in general from reſins by their greater ſolidity; by their ſmell, which is ſtronger, and not like the aromatic ſmell of reſins; by their inſolubility in ſpirit of wine; by the volatile ſulphureous acid, and by the concrete acid obtained in their analyſis.

The origin of bitumens is an intereſting queſtion, concerning which naturaliſts are not agreed; ſome imagining that they eſſentially belong to the mineral kingdom, and others that they proceed originally from vegetable ſubſtances. We muſt allow this latter opinion to be the moſt probable: for, firſt, no body, the origin of which is certainly mineral, contains the ſmalleſt portion of oil. Even ſulphur, which of all minerals approaches moſt to the nature of bitumens, and which all the ancient chemiſts have conſidered as ſuch, does

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earths and calxes, and combines with ſulphur, forming a very fuſible maſs; and laſtly, for *rendering ſome metals fitter for being caſt into moulds*, as a ſmall portion of it encreaſes their fuſibility.

(u) BISTRE is a brown pigment, conſiſting of the finer parts of wood-ſoot ſeparated from the groſſer by waſhing with water.

(w) BITTERN is the bitter ſaline liquor which remains after the cryſtallization of ſea-ſalt in ſea-water, or the water of ſalt ſprings. *See* WATER (SEA).

not contain, as Stahl has demonſtrated, the ſmalleſt veſtige of oil.

2dly, It is probable that the qualities by which bitumens differ from reſins and other oily matters, vegetable and animal, are either the natural effects of time upon theſe oily matters converted into bitumens, or of an alteration produced upon them by mineral acids; or rather they are the effect of both theſe cauſes united.

Thirdly, by combining mineral acids with vegetable oils, compounds may be formed much reſembling natural bitumens, and to which perhaps nothing but a ſufficiently long digeſtion is wanting to render them true bitumens.

Fourthly, we cannot doubt that the vegetable and animal matters continually deſtroyed on the ſurface of the earth, the juices of which are capable of penetrating further, muſt introduce into the earth much oily matter, which, in time, may become bitumen.

Beſides, natural hiſtory proves, that many entire vegetables and animals have been buried in large quantities, and even at conſiderable depths, by the various accidents and revolutions which have happened upon the earth; for under ground immenſe beds of turf are daily found, and large banks of half-decompoſed, bituminous, and petrified foſſil wood, which can be nothing elſe but conſiderable portions of the ſurface of the earth, thus buried by accidents too ancient to be remembered. All theſe matters are ſufficient to furniſh the earth with a large quantity of truly oily ſubſtance, which probably can be formed only in the organiſed bodies of vegetables and animals.

Junker deſcribes, after Neuman, the Pruſſian amber mines, which are the richeſt known. Firſt, at the ſurface of the earth is found a ſtratum of ſand. Immediately under this ſand is a bed of clay filled with ſmall flints of about an inch diameter each: under this clay lies a ſtratum of black earth or turf, filled with foſſil wood, half-decompoſed and bituminous: this ſtratum is extended upon a bank of minerals containing little metal, excepting iron, which are conſequently pyrites: laſtly, under this bed the amber is found ſcattered about in pieces, or ſometimes accumulated in heaps.

If we add to all this, that in amber are frequently included inſects and fragments of plants, we ſhall find a further probability that bitumens are of vegetable original.

It is true that amber, petroleum, and other bitumens are found in grounds where no foſſil vegetable matters exiſt;

but it is eaſy to conceive that theſe matters may have been deſtroyed, and their appearance changed by time, particularly as the different natures of ſoils contribute much to the preſervation or deſtruction of vegetable and animal ſubſtances.

Thoſe bitumens which are ſufficiently compact to be cut and poliſhed, ſuch as amber and jet, are formed into toys and ornaments, as necklaces, heads for canes, buttons, and mourning ear-rings.

Bitumens are alſo uſed for the preparation of very ſolid and beautiful oil varniſhes. For this purpoſe amber is chiefly uſed. *(x)*

BLACK-

(x) A *fine black varniſh* may eaſily be made by diſſolving amber previouſly melted in a crucible till it is rendered black, in boiling linſeed oil. But the ſolution of amber without decompoſition, by which its color is altered, in linſeed or other expreſſed oils, is more difficult, and has been unſucceſsfully attempted by Neuman and other chemiſts, with a view to make a pellucid hard varniſh. Hoffman ſays, that he reduced amber and oil of olives to a gelatinous maſs by placing the glaſs-veſſel containing them in Papin's Digeſtor, one third part of which was full of water. The experiments of Dr. Stockars are more deciſive. He ſays, that, by continuing a ſimmering heat during twelve hours, and by confining the vapors as much as ſtone-ware veſſels would bear, powdered amber was perfectly diſſolved in expreſſed oils, in turpentine, and in balſam of copaiba. He prevented the veſſels from burſting, by making ſmall notches in the corks with which he ſtopped them. The ſolutions of amber in oils of rape-ſeed and of almonds had a fine yellow color; in oil of linſeed a golden color; in oil of poppy a yellowiſh red; in oil of olives a beautiful red; in oil of nuts a deeper red; in oil of bays a purpliſh red. Solutions of amber in turpentine and balſam of copaiba had a deep red color, and when cooled, formed hard brittle red maſſes. All theſe ſolutions were eaſily miſcible with ſpirit of turpentine. Thoſe made with oils of linſeed, bays, poppies, and nuts, with balſam of copaiba, and with turpentine, being diluted with four times their quantity of ſpirit of turpentine, formed hard, tenacious, gloſſy varniſhes, which dried ſufficiently quick. *See Dr. Stockar's Specimen Inaugurale de Succino, Leyden,* 1700.

Amber may be rendered clear and pellucid by two methods. 1. By cementing lumps of it with ſand, during 40 hours, in an iron pot. 2. By digeſting them during 20 hours in boiling rapeſeed oil.

A *tincture* may be extracted from amber by rectified ſpirit of wine, or by ſweet ſpirit of vitriol.

From 16 oz. of coarſe amber Neuman obtained, *by diſtillation,* eleven ounces ſix drams of oil, four drams and a half of ſalt, *(ſee*

SALT

BLACK-JACK. *(z)*

BLOOD. Blood is well known to be a red liquor in moſt animals, circulating in their veſſels during life, and the common ſource whence all the neceſſary and ſuperfluous animal liquids are derived. *(a)*

Blood newly drawn from a ſound animal gives no ſign of an acid or alkaline quality. It has a ſweetiſh and ſomewhat ſaline taſte. When left to itſelf it coagulates, and quickly paſſes to a fermentation at firſt a little acid, and afterwards entirely putrid, in the ſame manner as all other perfectly animaliſed ſubſtances.

This liquor contains nothing volatile by the heat of boiling water, but a pure phlegm. Thus when blood is diſtilled in a water-bath, it is only dried, not entirely decompoſed. By this drying it loſes $\frac{7}{8}$ of its weight. The reſiduum being diſtilled in a naked fire, yields volatile alkali, and animal oil, at firſt thin, and afterwards thick: in the retort a charry reſiduum remains, which can difficultly be reduced to aſhes, from the lixiviation of which a little common ſalt may be obtained.

From this analyſis, which is almoſt all that chemiſts have done to diſcover the nature of the blood, it appears that this liquor contains the ſame principles as all other perfectly animaliſed matters. But a more accurate examination might probably be made of it by ſeparating at firſt from each other ſeveral different ſubſtances, of which the blood is only a collection or mixture, and then by analyſing each of theſe ſubſtances, as has been done with milk.

In fact, the blood being opake, or not very tranſparent, appears to be, as milk is, nothing elſe than a mixture of ſeveral heterogeneous matters confounded together, without being diſſolved by each other. It is known, that, when the blood is no longer circulated in the veſſels of the animal, but left at reſt in a veſſel, it coagulates and ſeparates ſpontaneouſly into a red maſs, and a white liquor, or ſerum, in which the red maſs floats; and that by waſhing, the red

(z) Black-Jack, or Blend, is a mineral, called alſo *falſe galena*. *See* Galena (False).

(a) The color of blood, like that of many other ſubſtances, is affected by expoſure to air, by which it acquires a ſcarlet tinge. Arterial blood has this ſcarlet color, which it has acquired by paſſing through the lungs in reſpiration. The blood flowing through the viens has a deeper and leſs vivid red color. It acquires the ſcarlet color by expoſure to air, and arterial blood loſes its vivid red color by excluſion from air.

part of this maſs may be carried off, and the remaining matter is white and gelatinous. There are then three diſtinct matters in the blood which ſeem to correſpond with thoſe contained in milk; that is, the ſerum of the blood correſponds with the whey of milk; the white gelatinous matter, with the cheeſy part; and laſtly, the red globules with the butyraceous ſubſtance.

It is ſo much more probable that the red part of the blood is oleaginous, as anatomiſts, who have examined the blood by microſcopes, have obſerved that this red part is compoſed of globules ſwiming in a white liquor, and as all oily matters, when well mixed, but not diſſolved in a watery fluid, have this globular appearance. *(b)*

This being eſtabliſhed, if the blood were to be examined more exactly than it has hitherto been, it would probably be neceſſary to begin by ſeparating from each other the three above-mentioned ſubſtances, each of which ought afterwards to be ſubjected to experiments and analyſes, as has been done with milk. It is probable that this method of analyſing blood would throw new light upon its nature and principles, which are yet very imperfectly underſtood, as well as thoſe of other animal matters.

The purely gelatinous parts of the blood are probably not different from any other animal jelly: but it is to be preſumed that ſome peculiar ſalts might be obtained from the ſerous parts, as have been from milk and from urine; and that the red globular part would be found to be oleaginous. The acid, or volatile alkaline principles which would be obtained from the red part of the blood would determine whether or not it is a truly animal oil, or fat. If it be true, as Mr. Homberg and Mr. Macquer affim, that ſome acid may be obtained by analyſing the blood, it would probably be found to belong to this red ſubſtance.

(b) The red particles of blood have been generally thought to be globules. Father *de la Torré* pretends to have diſcovered from his microſcopical obſervations that they have an annular form. But Mr. *Hewſon* maintains that the central ſpot taken by Father de la Torré for a hole, is a ſolid dark-colored particle contained in the middle of a tranſparent veſicle, which is flat like a piece of money, and not globular. This veſicle, he ſays, is empty, or filled with a ſubtle fluid, and is capable of being diſſolved by water, as alſo is the ſolid red particle. See Mr. William Hewſon's paper in the *Philoſ. Tranſ.* vol. 63. *on the figure and compoſition of the red particles of blood*; and alſo, Mr. Hewſon's *experiments on the blood. Phil. Tranſ. vol.* 60.

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Laſtly, it is evident that whatever knowledge could be acquired on this ſubject by well-conducted experiments, muſt extend and encreaſe an intereſting branch of our knowledge, namely, that concerning animal economy. *(c)*

BLUE. *(d)*

BLUE

(c) Dr. George Fordyce, in his very excellent Elements of the Practice of Phyſic, ſays, that the white gelatinous matter of the blood, or *coagulable lymph*, continues fluid while circulating with any degree of heat betwixt 30 and 120° of Fahrenheit's thermometer; but that it is coagulated very ſoon after it is taken out of the body in any heat, in motion, or in reſt; and that its coagulation may be prevented by ſaturating the blood with ſea-ſalt, or perhaps with ſome other neutral ſalts. The coagulum is rendered ſoluble in boiling water, by putrefaction, by concentrated acids, cauſtic alkalis, calcareous earths, and by ſome metallic ſalts. He obſerves alſo, that the coagulable lymph is more fluid, and is not ſo eaſily coagulable when the arteries of the perſon from whom the blood is drawn act more ſtrongly than they uſually do; in which caſe, the red particles and this lymph can ſeparate more exactly from each other according to their denſities, the former falling to the bottom, and the greateſt part of the latter forming upon the upper ſurface a very viſcid tough maſs called the *buff*. By putrefaction the coagulable lymph and ſerum are converted into a mucilaginous matter, not coagulable by any of the methods recited above, which mucilaginous matter may be converted by further putrefaction into ſaline ſubſtances and calcareaus earth. The red part of the blood is readily ſoluble in water, but not in ſerum, nor in a ſaturated ſolution of neutral ſalts. By the firſt ſtage of putrefaction this red part of blood is broken down into ſmaller particles, its color is rendered darker, and afterwards it is converted into a mucilage ſoluble in ſerum.

From the ſolubility of the red particles of blood in water, it evidently appears that they are not oleaginous, as the author of the Dictionary ſeems inclined to believe.

(d) BLUE COLORING MATERIALS. Concerning the blue glaſs called *ſmalt*, prepared from the ore of regulus of cobalt; the preparation of iron called *Pruſſian blue*; and the preparation of lapis lazuli called *ultramarine* or *azure*, *ſee* SMALT, AZURE *and* BLUE (PRUSSIAN). The *blue color of flowers* is ſo periſhable as to be of little uſe in dying. It is extracted from many by infuſion in water, but not in ſpirit. It is changed by acids to a red not more durable than the original blue; by marine acid to the moſt florid red; and it is changed by alkalis and by lime-water to a green, which afterwards becomes a yellow. The green by lime-water is the more permanent and beautiful, and has been formed into lakes for painting. The two principal vegetable ſubſtances uſed for dying of a blue color are *indigo* and *woad*.

Theſe

BLUE (PRUSSIAN). Pruſſian blue is a precipitate of iron with a ſuperabundant quantity of phlogiſton, from which it receives a very beautiful color.

This blue, which is ſucceſsfully uſed in painting, was diſcovered, like moſt other things, by accident, and about the beginning of this century.

Stahl relates in his *Three hundred Experiments*, N° 231, the manner in which this blue was diſcovered. He ſays, that a manufacturer of colors, called *Dieſbach*, who uſually prepared a lake of cochineal, by mixing a decoction of this ſubſtance with alum and ſome green vitriol, and by precipitating the mixture with a fixed alkali, being one day in want of fixed alkali, borrowed from Dippel, in whoſe laboratory he worked, ſome ſalt of tartar from which that chemiſt had ſeveral times diſtilled his animal oil, and obſerved that the lake precipitated by means of this alkali, inſtead of being red, was of a fine blue color. Dippel, to whom he related the appearance, knew that it muſt have been cauſed by his alkali, and attempted to produce the ſame effects by giving the ſame quality to fixed alkali by an eaſier proceſs. His attempts ſucceeded, and from that time Pruſſian blue has been made.

An account of this blue, called *Pruſſian* or *Berlin blue*, from the place where it was made, was publiſhed in the Berlin Memoirs for 1710, but no deſcription was given of the proceſs for making it.

Several chemiſts undoubtedly attempted to diſcover it: accordingly it was diſcovered, and in the year 1724 Dr. Woodward publiſhed it in the Philoſophical Tranſactions. The proceſs ſucceeds very well, and is as follows:

Alkaliſe together four ounces of nitre and as much tartar. *See* ALKALI (EXTEMPORANEOUS). Mix this alkali well with four ounces of dried bullocks blood, and put the whole in a crucible covered with a lid in which there is a ſmall hole: calcine with a moderate fire till the blood be reduced

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Theſe are feculæ or ſediments depoſited by fermentation from infuſions of the leaves of the plants *anil*, and *woad*, or *glaſtum*. Hellot thinks, that a ſimilar blue dye might be obtained from moſt other vegetables, and that the green of vegetables is cauſed by a mixture of blue and yellow coloring particles, of which the blue is the moſt durable, and leaſt affected by fermentations. The colors given by both indigo and woad are at firſt green, but are ſoon changed, by expoſure to air, to blue. A blue tincture may be made from *nephritic* wood, which has not been applied to any uſe. The *eſſential oils of camomile, milfoil, pimpinella nigra*, are blue, and by keeping become green and yellow. *See* DYING.

to a perfect coal; that is, till it emits no more ſmoke or flame capable of blackening any white bodies that are expoſed to it: increaſe the fire towards the end, ſo that the whole matter contained in the crucible ſhall be moderately, but ſenſibly red.

Throw into two pints of water the matter contained in the crucible, while yet red, and give it half an hour's boiling: decant this firſt water, and pour more water upon the black and charry coal till it becomes almoſt inſipid: mix together all theſe waters, and reduce them by boiling to about two pints.

Alſo diſſolve two ounces of martial vitriol, and eight ounces of alum in two pints of boiling water: mix this ſolution when hot, with the preceding lixivium, alſo hot. A great effervеſcence will then be made. The liquors will be rendered turbid, and will become of a green color more or leſs blue, and a precipitate will be formed of the ſame color. Filtrate, in order to ſeparate this precipitate, upon which pour ſpirit of ſalt, and mix them well together, by which means the precipitate will become of a fine blue color. It is neceſſary to add rather too much ſpirit of ſalt than too little, and till it no longer encreaſes the beauty of the precipitate. The next day waſh this blue till the water comes off from it inſipid, and then gently dry it. Such is the proceſs by which Pruſſian blue is made. Chemiſts, after having diſcovered it, endeavoured to find the theory of it, and to explain the appearances in the ſeveral operations of the proceſs. There have been ſeveral opinions concerning the nature of Pruſſian blue.

Mr. John Brown of the Royal Society of London thinks, that this blue is the bituminous or phlogiſtic part of iron, diſengaged by the lixivium of bullock's blood, and applied to the earth of alum. This opinion has been adopted by Dr. Geoffroy in the Memoirs given by him on this ſubject, which are found in the collection of the Academy of Sciences for the year 1725.

The Abbé Menon, a correſpondent of the Academy of Sciences, in Memoirs printed amongſt the collection of the *Sçavans Eſtrangers*, publiſhed by the academy, advances and endeavours to prove that Pruſſian blue is nothing but iron entirely freed from all ſaline matter by the phlogiſton of the alkaline lixivium, and precipitated with its natural color, which, he pretends, is blue. He thinks that the uſe of the alum is to diminiſh the intenſity of the color by the whiteneſs of its earth.

Laſtly, Mr. Macquer, having examined this matter in all its extent, has publiſhed a memoir amongſt thoſe of the Academy of Sciences for the year 1752, in which he concludes, after having related many experiments, that Pruſſian blue is nothing but iron impregnated with a ſuperabundant quantity of phlogiſton, which it receives from the phlogiſticated alkaline precipitant. The experiments and diſcoveries made by this chemiſt are as follow.

Mr. Macquer firſt obſerves that very pure alkaline ſalts ſeparate iron, as they do all metallic ſubſtances, from acids; and that iron ſo precipitated has a color more or leſs yellow, and is ſoluble by acids.

If, on the contrary, this precipitation of iron be made by an alkali previouſly calcined with an inflammable matter, then a precipitate is formed, more or leſs green or blue, as the alkali was more or leſs phlogiſticated.

If an acid be poured upon this green precipitate, experiments ſhew that this acid diſſolves one part of it, and does not act upon the other. This proves that the green precipitate is not homogeneous, but a mixture of two precipitates, one of which is ſoluble, and the other is inſoluble by an acid.

As the precipitate which reſiſts the action of acids is very blue, when ſeparated from that which the acid has diſſolved, and as the green color of the mixed precipitate is a mixture of yellow and blue; the author concludes that the part diſſolved by the acid is yellow, and conſequently that this portion of green precipitate is entirely ſimilar to the iron which pure alkalis ſeparate from acids.

As to the blue precipitate, as it not only reſiſts the action of acids but alſo of magnets, it might not be known to be iron, if a ſlight calcination did not at once deprive it of its blue color, and render it entirely ſimilar to other iron.

Theſe facts prove that Pruſſian blue is nothing but iron united with ſome matter which gives it a blue color, and the property of reſiſting the action of acids and of magnets.

Mr. Macquer has further diſcovered, that fire is not the only means by which the Pruſſian blue may be deprived of all the properties, by which it differs from ordinary iron.

A very pure alkali produces alſo the ſame effect. He has alſo diſcovered, that the alkali which has thus deprived the Pruſſian blue of all the properties which diſtinguiſh it from ordinary iron, becomes by that operation entirely ſimilar to the phlogiſticated alkali uſed for the preparation of Pruſſian blue.

Theſe facts ſeem to demonſtrate that Pruſſian blue is nothing elſe than iron, which becomes blue by being impregnated with a matter which the alkali is capable of giving to it or of ſeparating from it, according to circumſtances; that is to ſay, that when the alkali is impregnated with this matter, and is applied to iron diſſolved in an acid, it then combines with this acid, and precipitates the iron, to which it transfers at the ſame time the matter which changes the iron into Pruſſian blue. But if on the contrary Pruſſian blue be applied to pure alkali, then this alkali entirely diſſolves the coloring matter of the Pruſſian blue, and takes it from the iron, which is thus reduced to its ordinary condition.

By a more particular examination of this alkali, impregnated with the coloring matter of Pruſſian blue, either by calcination with an inflammable matter, or by taking the color from Pruſſian blue itſelf, Mr. Macquer found that its alkaline properties were ſo much more weakened, as it was impregnated with a larger portion of this coloring matter. This induced him to preſume, that by giving it a ſufficient quantity of Pruſſian blue to diſcolor, it might be entirely ſaturated with this coloring matter: and the event entirely anſwered his expectation.

By applying much Pruſſian blue to an alkali, this latter was ſo ſaturated that it no longer diſcolored the blue when boiled together, and upon trial, was found to poſſeſs no longer any alkaline qualities.

A ſolution of iron by any acid poured into this alkali, ſaturated with the coloring matter of the Pruſſian blue, forms immediately a precipitate, not green, compoſed of yellow and blue, the former of which muſt be ſeparated by an acid from the latter to obtain this of a pure blue color, as in the ordinary proceſs for the preparation of Pruſſian blue, but a ſingle homogeneous precipitate, and a perfect Pruſſian blue. This effect ought neceſſarily to happen, becauſe the ſaturated alkali contains no part purely alkaline which can occaſion a precipitate of ſoluble iron, as pure alkalis do.

But an eſſential phenomenon, and not obſerved by any former chemiſt, is, that it is not merely by the action of the acid, which diſſolves the iron, that the coloring matter is applied to the iron, and thus the Pruſſian blue formed; but that the affinity of this matter to iron contributes alſo to produce this effect. The author has demonſtrated this truth by the following deciſive experiment.

If any pure acid be poured upon an alkali perfectly ſaturated with the coloring matter of Pruſſian blue, this acid contracts no union with this alkali, nor is any-ways neutralized, and conſequently is incapable of ſeparating the coloring matter of Pruſſian blue. It only procures this ſeparation when it is united with iron, the affinity of which to the coloring matter, being joined to the affinity of the acid to the alkali, form a ſum of affinities capable of occaſioning the ſeparation of which we treat.

In this operation, therefore, there is a very diſtinct example of the effect of double or united affinities. *See* AFFINITY. This example is even ſo much more compleat, as it is amongſt the moſt general that chemiſtry furniſhes. For according to Mr. Macquer's obſervations, iron is not the only metallic ſubſtance, the affinity of which being united with that of the acid, procures the ſeparation of the coloring matter of the Pruſſian blue from the alkali; but any metallic ſubſtance diſſolved in any acid ſeparates the phlogiſtic matter from all alkalis, fixed or volatile. This is aſcertained by Mr. Macquer's experiments, a detail of which may be ſeen in his memoir.

Another no leſs important phenomenon, which none of the chemiſts who have endeavoured to explain the theory of Pruſſian blue had obſerved, is, that earths have not the ſame affinity as metallic ſubſtances with the phlogiſtic matter of Pruſſian blue. Hence if an alkali ſaturated with this coloring matter be poured into a ſolution of alum, no decompoſition is effected, nor is any precipitate formed. The alum continues alum, and the ſaturated alkali remains unchanged.

After this experiment Mr. Macquer reaſonably concludes, that the alum added in the operation of Pruſſian blue does not directly contribute to the production of this blue. The purpoſe to which it ſerves is as follows. (*e*)

This chemiſt proved by many experiments, that an alkali can never be entirely ſaturated with the coloring matter of

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(*e*) Alum is an ingredient in the above-mentioned receipt for making Pruſſian blue firſt publiſhed by Dr. Woodward; but whether it be uſeful has not been aſcertained by experiment. I have found that as good Pruſſian blue may be made without as with alum; and that when this ſaline ſubſtance is uſed in the compoſition, no good and intenſe blue can be obtained, till all the earth of alum, which had been precipitated, be again diſſolved by the marine or other mineral acid, all which are equally effectual.

Pruſſian blue by calcination. This being eſtabliſhed, it is certain that alkalis, calcined with inflammable ſubſtances to make the proper lixivium for Pruſſian blue, ſtill remain alkaline. Hence it happens, that when they are mixed with a ſolution of green vitriol, they form by their purely alkaline part a yellow precipitate, ſo much more copious as this purely alkaline part is itſelf more copious. But nothing is more capable of ſpoiling the color of the portion of iron precipitated in Pruſſian blue than a mixture of this yellow or olive-colored precipitate; therefore a large quantity of acid muſt be employed, that this yellow precipitate may be entirely diſſolved, if we mean to have a very fine blue.

Part of theſe inconveniencies is avoided by mixing a ſolution of alum with a ſolution of green vitriol. By this means, the purely alkaline part of the lixivium is moſtly employed to precipitate a greater or leſs quantity of the earth of alum, and conſequently the quantity of yellow ferruginous precipitate is much diminiſhed. But the earth of alum being of a fine ſhining white does not in the leaſt alter the purity of the blue color, but enlivens it, and leſſens its intenſity; which is frequently no inconvenience, becauſe the Pruſſian blue, when it is not of the fineſt color, is always too dark and black.

It follows from what has been ſaid, that when Pruſſian blue is to be made with a lixivium not ſaturated, it is a matter of indifference whether the green precipitate is to be again diſſolved, or the alkaline part of the lixivium ſaturated with alum or with an acid, before the precipitate is formed. The only difference which can proceed from theſe modes of management is, that in the former caſe, all the part of the precipitate which is not Pruſſian blue is rediſſolved by an acid; whereas in the latter caſe, this mixed precipitation is prevented, and nothing is thrown down but true Pruſſian blue.

It is proper to obſerve, concerning the theory of Pruſſian blue, that moſt alkalis obtained from the aſhes of vegetables, being combined by their combuſtion with a portion of inflammable matter, are capable of furniſhing a quantity of Pruſſian blue proportionable to the quantity retained by them of this inflammable matter, even without the neceſſity of mixing them with a ſolution of iron, becauſe they always contain a little of this metal diſſolved, ſome of which may be found in almoſt all vegetables; therefore it is ſufficient for this purpoſe to ſaturate them with an acid. Theſe materials which form Pruſſian blue in alkaline ſalts occaſion their impurity, and require much trouble to be perfectly ſeparated.

Some chemiſts had even perceived the production of this blue in the ſaturation of alkaline ſalts, before the diſcovery of the Pruſſian blue: and Henkel particularly, who had obſerved it in the ſaturation of the ſalt of ſoda, or foſſil alkali, recommended to chemiſts an enquiry concerning the nature of this blue. Thus chemiſts had already acquired ſome ſort of knowledge on this ſubject, and therefore the Pruſſian blue could not have long remained unknown, even if accident had not preſented it in ſo ſtriking a manner to the chemiſt of Berlin, who was the firſt who prepared it in ſufficient quantity for the uſes of painters.

BLUE (SAXON). *(f)*

BOLE. Boles, or bolar earths, are clays which adhere to the tongue, when applied dry, and which are colored, yellow and red, by a ferruginous earth. *See* CLAY.

BOLOGNIAN STONE. *See* STONE.

BONES. *(g)*

(f) BLUE (SAXON). The beſt Saxon blue color may be given by the following compoſition.

" Mix one ounce of the beſt powdered indigo with four ounces of oil of vitriol in a glaſs body or matraſs; and digeſt it for one hour with the heat of boiling water, ſhaking the mixture at different times; then add twelve ounces of water to it, and ſtir the whole well, and when grown cold filter it. This produces a very rich deep color; if a paler blue be required, it may be obtained by the addition of more water. The heat of boiling water is ſufficient for this operation, and can never ſpoil the color; whereas a ſand heat which is commonly uſed is often found to damage the color.

" Indigo which has been digeſted with a large quantity of ſpirit of wine and then dried, will produce a finer color than the former, if treated in the ſame manner with oil of vitriol." *Experiments to ſhew the nature of Aurum Moſaicum, by Mr.* Peter Wolfe. *Phil. Tranſ.* 61.

(g) BONES are totally ſoluble in concentrated acids of vitriol, nitre, and ſea-ſalt, and may be ſoftened by theſe acids diluted, or by vinegar. From two ounces of ox-bone Neuman obtained by diſtillation two drams of empyreumatic phlegm, one dram of volatile urinous ſpirit, two ſcruples of volatile alkali, two ſcruples of fetid oil, and one ounce, three drams, and two ſcruples of reſiduum. Dr. Lewis obſerves, that bones expoſed to a heat gradually raiſed are rendered white, opake, and friable; and when expoſed ſuddenly to a violent heat, are rendered hard, ſemi-tranſparent, and ſonorous. Bones and horns may be ſtained by the common dying infuſions and decoctions of vegetable and animal ſubſtances, and by metallic ſolutions.

BORAX. Borax is a ſaline matter, with all the properties of a neutral ſalt.

It is ſoluble in water, and cryſtallizable nearly as alum is; with this difference only, that it requires a little more water for its ſolution, and retains ſomewhat leſs in its cryſtallization.

When expoſed to fire, it at firſt undergoes the liquefaction occaſioned by the water of its cryſtallization, and is then calcined, as alum is, but is not ſo much ſwelled and rarefied during the operation.

If the fire be increaſed to a melting heat, the borax is pretty eaſily fuſed, and is converted into a vitreous matter, or ſaline glaſs: and when it is mixed with earths of any kind, it acts as a flux, and converts them into more or leſs tranſparent glaſſes according to their natures. *See* VITRIFICATION.

Glaſs of borax is very friable, eaſily tarniſhes in the air, and becomes mealy, nearly as the alkaline baſis of ſea-ſalt does. It is entirely ſoluble in water; and when the ſolution of it is evaporated, borax is again formed in cryſtals, as it was before its fuſion.

Borax then ſuffers no decompoſition by fire, even in open veſſels, and certainly, therefore, not in cloſe ones.

But it may be decompoſed by the vitriolic, nitrous, and marine acids, which unite with the ſaline alkaline matter which is its baſis, and form with it exactly the ſame neutral ſalts as thoſe which reſult from the union of theſe acids with the marine alkali; that is to ſay, the vitriolic acid forms Glauber's ſalt, the nitrous acid forms cubic nitre, and the marine acid forms ſea-ſalt.

When acids combine thus with the alkaline baſis of borax, they ſeparate from it a ſaline ſubſtance of a ſingular nature, and little underſtood, called *Sedative Salt*. *See* SALT (SEDATIVE).

We are far from knowing as much concerning borax as is deſirable. We are even ignorant of its origin, which might ſupply the want of a perfect analyſis, and give light to the nature of this ſaline ſubſtance.

As borax is not found in Europe, it is brought from the Eaſt-Indies in a ſtate which only requires a ſlight purification, which is given to it by the Dutch and Venetians who are the chief merchants of it. But it is not yet known whether this matter be a natural or an artificial ſubſtance, nor whence, nor how it is obtained.

Our ignorance concerning borax is certainly owing to the intereſt, which they, who make a lucrative commerce of it, have to keep every thing concerning its origin ſecret.

However that be, notwithſtanding the reſources which chemiſts poſſeſs of diſcovering by their experiments what is hid from them, it appears that they were long in a ſtate of indifference concerning borax. Satisfied with employing it in their operations, in which it is very uſeful as a flux, they long uſed it without attempting to ſubject it to proper proofs for the diſcovery of its nature.

In the writings of Becher and Stahl we ſcarcely find any thing concerning borax. The examination by chemical means of this ſubſtance, which ought to excite the curioſity of chemiſts, has been begun only in theſe later times; and it is to the praiſe of the French, that almoſt all the knowledge we have concerning it we owe to them alone.

Homberg was amongſt the firſt who undertook a ſet of experiments on borax, by which the ſedative ſalt was diſcovered, which was a new ſubſtance, and entirely unknown before him. Homberg obtained the ſedative ſalt from borax, by diſtilling it with vitriol; and imagining that he diſcovered a ſedative or quieting power in it, he called it the *Narcotic Salt of Vitriol*, or *Sedative Salt.* This chemiſt did not well underſtand the theory of his experiment; but that is not ſurpriſing in matters ſo new.

The younger Lemeri, who after Homberg made many experiments on borax, diſcovered that ſedative ſalt may be obtained from it, not only by the vitriolic acid, but alſo by the nitrous and marine acids. This diſcovery was the more important, as it naturally led to further: but he ſeems to have been prevented by other purſuits from continuing this ſubject as it ought to be.

Homberg and Lemeri obtained ſedative ſalt only by diſtillation or ſublimation, which, particularly in this caſe, was a long and embarraſſing operation. M. Geoffroy has improved upon their diſcoveries, by ſhewing the method of obtaining the ſame ſalt from borax by acids with evaporation and cryſtallization only, in greater quantity and with leſs trouble. We are alſo obliged to him for having firſt demonſtrated that borax contains the baſis of ſea-ſalt. This truth he has firmly eſtabliſhed, by obtaining a true Glauber's ſalt by mixing vitriolic acid with a ſolution of borax.

Laſtly, Mr. Baron, Member of the Academy of Sciences, and of the Faculty of Medicine at Paris, proved by many experiments that ſedative ſalt of borax may be obtained by means of vegetable acids, which had not been done before him. He has alſo proved, that ſedative ſalt is not a combination of an alkaline matter with the acid employed to obtain it, but that it exiſts ready formed in borax, of which it is a principal or conſtituent part; that the acids employed to extract it do only diſengage it from the alkali with which it is united; that this alkali is entirely ſimilar to that of ſea-ſalt; that ſedative ſalt may be re-united with its alkali, and again form borax; which is a complete proof that borax is nothing elſe than a compound of ſedative ſalt, and marine alkali.

Nothing more then remains to have, on the nature of borax, all the knowledge we can deſire, than to diſcover what this ſedative ſalt is. The experiment by which Mr. Baron found that this ſalt is capable of decompoſing nitre and marine ſalt, by ſeparating the acids of theſe ſalts by help of fire, ſeems to ſhew that vitriolic acid is one of the principles of the ſedative ſalt. But to prove this deciſively, the ſedative ſalt itſelf muſt be decompoſed. This is the ſubject of Mr. Bourdelin's late admirable experiments. Although this able chemiſt has not been able to accompliſh his purpoſe by all the methods which the moſt profound chemiſtry can ſuggeſt, his experiments are nevertheleſs uſeful, as they may prevent others from employing their time and labor in making them, and alſo becauſe they make us better acquainted with the properties of the ſedative ſalt. *See* SALT (SEDATIVE). *(b)*

BRAINS.

(b) Borax, when crude, as it is brought from the Eaſt-Indies, is called *Tincal.* In this ſtate, it conſiſts of ſmall, yellow, glutinous cryſtals. It is ſaid to be refined by lime water. Refined borax conſiſts of large, white, eight-ſided cryſtals, each of which is compoſed of ſmall, ſoft, bitteriſh ſcales. It is difficultly ſoluble in water, to which it gives a glutinous quality, and hence is uſed by dyers to give a gloſs to ſilks. It is alſo ſoluble in ſpirit of wine, to the flame of which it gives a green color. By repeatedly moiſtening it, while it is conſiderably heated, it may be entirely ſublimed. Borax renders all earths and ſtones fuſible by fire, and hence is uſed for the eſſaying of ores. It alſo facilitates the fuſion of metals; and is particularly uſeful when ſmall particles of metal mixed with dirt and aſhes are to be melted together; as it promotes the fuſion of the metal, and the vitrification of the other matters, by which the particles of metal may diſengage themſelves, and collect into one maſs. It is further uſeful in the fuſion of metals, as it defends their ſurfaces from

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BRAINS. (*i*)

BRANDY. (*k*)

BRASS. Braſs, called alſo *Latten*, is a mixture of very pure copper, with a fourth part of very pure zinc, by which the color of the copper is rendered of a fine golden yellow. This is undoubtedly the moſt uſeful and neceſſary of all the mixtures of copper and other metals, chiefly on account of the copper's preſerving ſo much of its ductility, when combined with that proportion of zinc.

Although zinc be only a ſemi-metal, and conſequently not ductile, and although metallic mixtures be generally leſs ductile than the pure metals of which they are compoſed, zinc ſeems to be an exception to this rule in its

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the combined action of air and fire, by which imperfect metals are calcined. Crucibles in which gold and ſilver are melted ought to be previouſly glazed on their inner ſurfaces with borax, that when the metals are poured out, no particles may adhere to the ſides of the crucibles. Gold is rendered pale by fuſion with borax, which effect is prevented by adding a little nitre or ſal-ammoniac, or is remedied by remelting the gold with either of theſe ſalts. Dr. Lewis obſerves, that borax alſo renders braſs and Prince's-metal pale, and at the ſame time acquires a deep red color. This color it probably receives from ſome part of the copper contained in theſe compound metals, as it acquires the ſame red color by fuſion with copper. Borax is not, as ſome ſuppoſe, a ſubſtance capable of reducing or reviving calcined metals, but is uſed with the intentions above deſcribed. A principal uſe of borax is to facilitate the ſoldering of metals, which it does by accelerating the fuſion of the ſurfaces of the metals to be joined, and by clearing them from any calx or other matter by which they might be prevented from being perfectly applied to each other. Borax is alſo uſed for the preparation of ſome fine glaſſes, and imitations of precious ſtones; becauſe the glaſſes prepared by fuſing it with earths are hard, compact, bright, and very tranſparent; but by long expoſure to air they loſe much of their luſtre, become cloudy, and when the quantity employed has been large, even opake.

(*i*) BRAINS. From 16 oz. of ox's brains, Neuman obtained by diſtillation ſix ounces, two drams, and two ſcruples of a colorleſs phlegm; four ounces and four ſcruples of a volatile, empyreumatic ſpirit; which being rectified, produced two ſcruples of a volatile concrete ſalt, and one ounce of caput mortuum, from which, by elixation, were procured 25 grains of fixed ſalt.

(*k*) BRANDY is an ardent ſpirit diſtilled from wine. For its properties, *ſee* SPIRIT. It is ſaid to be imitated by adding to very pure malt ſpirits ſome dulcified ſpirit of nitre.

combination with copper; for it has the property of uniting with that metal in a large proportion, as of a third, or a fourth, without ſenſibly diminiſhing the ductility of the copper. But as this property is quite peculiar to zinc, it is evident that it is neceſſary, in order to make good braſs, that the copper and zinc be, each of them, in their greateſt purity.

If ſuch zinc as is procured in the ſmelting of ores be melted with copper, as in ſome mixtures commonly uſed, we might indeed obtain a very fine-colored braſs, but it would be brittle and unmalleable. It would only be a mixture of that kind called *tombacs*, becauſe this zinc is never very pure. *See* ZINC.

This inconvenience is avoided in making braſs, by a kind of cementation with the ore of zinc, which is lapis calaminaris. This proceſs is performed in the following manner.

A cement, compoſed of one part and a half of good lapis calaminaris and powder of charcoal triturated together, and moiſtened with water, is put into an earthen pot or crucible. Then one part of very pure copper beat into plates, is placed over the cement, and the whole is covered with charcoal duſt. The crucible is then cloſed, and is heated only enough to make it gradually become red. When the flame of the coals has acquired a cupreous color, an iron rod is introduced into the crucible, to try if the copper be melted under the cementing powder. If that be the caſe, the action of the fire is moderated, and in a few minutes the crucible is taken out.

When it is cooled, the copper is found to have become yellow, and to have received an augmentation of a fourth, and ſometimes of a third of its weight, and is nevertheleſs very malleable.

This proceſs is a kind of cementation, in which the zinc is raiſed from its ore in vapors, and combines with the copper. This method is advantageous, principally becauſe the other metallic matters, and particularly the iron, from which lapis calaminaris is ſeldom free, do not riſe in vapors, and conſequently cannot combine with the copper.

In order to effect this purpoſe more certainly, the cementing powder may be mixed up with clay into a paſte; which being put in the bottom of the crucible, is to be covered with plates of copper and charcoal powder, proceeding as is directed above. The copper, penetrated by the vapors of the zinc which paſs through the paſte, melts upon the ſurface of the paſte, and does not mix with the other metals, which always alters the color and ductility of the braſs. Theſe proceſſes are from M. Cramer.

The advantages of converting copper into braſs are, that its weight is augmented one fourth part; that its color is changed to one more agreeable, as it approaches the color of gold; that it is more fuſible; and laſtly, that it is leſs ſubject to ruſt, becauſe zinc is leſs ſuſceptible than copper of being altered by the action of air and of water.

Although zinc be fixed to a certain degree in braſs by the adheſion it contracts with the copper, yet when braſs is melted and expoſed to a violent fire during a certain time, the zinc diſſipates in vapors, and even flames away, if the heat be ſtrong enough; and if the heat laſts long enough, all the zinc will be evaporated and deſtroyed, and the copper alone will remain.

Copper, or copper converted into braſs, or in any other form, but particularly when penetrated by any ſalts and reduced into verdigriſe, produces always, when taken internally, the moſt troubleſome conſequences, and becomes a poiſon. For this reaſon it is dangerous to uſe copper utenſils and veſſels for the purpoſe of cookery, and in many places they begin to be diſuſed.

For the ſame reaſon alſo, none of the preparations of this metal are ever employed medicinally by prudent phyſicians. It appears, however, to enter into the compoſition of a remedy much uſed, the *Lilly of Paracelſus*, or *Tincture of Metals:* but in fact, it is certain that the ſpirit of wine, employed for the preparation of this medicine, diſſolves nothing of the calx of copper, or of the other calxes of metallic ſubſtances digeſted in it. Mr. Beaumé convinced himſelf of this fact by a moſt accurate examination of the *Lilly of Paracelſus.*

The beſt remedies for perſons poiſoned by verdigriſe, are mild, watery, mucilaginous, and oily drinks, given quickly and copiouſly, which ought to be immediately ſucceeded by evacuants to carry off the poiſon as faſt as is poſſible.

The uſe of copper then in medicine is confined to external applications. It is ſtimulant, tonic, and deterſive. Verdigriſe enters into the unguentum Egyptiacum, into ſeveral plaſters, the collyrium of Lanfranc, and the green balſam of Metz. A blue water for the eyes is made with copper and ſal ammoniac, which is called *Celeſtial water.* (l)

BREAD.

(l) Brass. As the manufacture of braſs is important in commerce, a detail of the proceſs by which it is made may be acceptable. The calamine is previouſly to be prepared by cleanſing it from adhering earth, ſtone or other matters; by roaſting or calcining it; and by grinding it into a fine powder. The calcination, by which moiſture and ſmall portions of ſulphur and other volatile matters are diſſipated, may be performed either in a reverberatory furnace, in which the calamine is kept till it be thoroughly red hot; and that this heat may be more equally given to it all at the ſame time, it ought to be frequently ſtirred; or by ſetting fire to a conical pile, compoſed of horizontal layers of calamine, and of charcoal placed alternately one upon the other, and of a lower ſtratum conſiſting of large pieces of wood; in which lower ſtratum are four horizontal channels, through which the air maintaining the fire paſſes to the center, and thence ariſes through a chimney or perpendicular empty ſpace, left for that purpoſe, along the axis of the conical pile. If the calcining heat be too intenſe or too long continued, part of the contained zinc may be diſſipated; and if it be not ſufficiently intenſe, or long enough continued, the volatile matters will not be entirely expelled, and the texture of the ſtone will not be ſufficiently broken to prepare it for the ſubſequent grinding. The length of time and degree of heat requiſite for the calcination of calamine, are different according to the qualities of that mineral. The calamine thus cleanſed, calcined, and ground, is to be mixed with about a third or fourth part of powder of charcoal, or of pit-coal, as is done in ſome parts of England. The malleability of the braſs is diminiſhed by the uſe of pit-coal, which is therefore employed only for the preparation of coarſer kinds of braſs. To this compoſition of calamine and coal ſome manufacturers add common ſalt, by which the proceſs of making braſs is ſaid to be haſtened. In Goſlar, where the cadmia adhering to the inner ſides of furnaces is employed, inſtead of native calamine, a ſmall quantity of alum is added, by which they pretend the color of the braſs is heightened. With this compoſition, and with thin plates or grains of copper, the crucibles are to be nearly filled. The proportion of calamine to the copper varies according to the richneſs of the former, but is generally as three to two. The copper muſt be diſperſed through the compoſition of calamine and coal, and the whole muſt be covered with more coal till the crucibles are full. The crucibles thus filled are to be placed in a furnace ſunk in the ground, the form of which furnace is that of the fruſtum of a hollow cone. At the bottom of the furnace, or greater baſis of the fruſtum, is a circular grate, or iron plate. This plate is covered with a coat of clay and horſe-dung to

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BREAD. The grains of all vegetables are almoſt entirely compoſed of ſubſtances very proper for the nouriſhment

defend it from the action of the fire, and pierced with holes, through which the air maintaining the fire paſſes. The crucibles ſtand upon the circular plate, forming a circular row with one in the middle. The fuel is placed betwixt the crucibles, and is thrown into the furnace at the upper part of it, or the leſſer baſis of the fruſtum. To this upper part or mouth of the furnace is fitted a cover made of bricks or clay, kept together by bars of iron, and pierced with holes. This cover ſerves as a regiſter. When the heat is to be encreaſed, the cover is to be partly or entirely taken off, and a free draught is permitted to the external air, which paſſes along a vault under ground to the aſh-hole, through the holes in the circular grate or plate, betwixt the crucibles, and through the upper mouth along with the ſmoke and flame into an area where the workmen ſtand, which is covered with a large dome or chimney through which the ſmoke and air aſcend. When the heat is to be diminiſhed, the mouth of the furnace is to be cloſed with the lid, through the holes of which the air, ſmoke, and flame paſs. The crucibles are to be kept red-hot during eight or ten hours, and in ſome places much longer, even ſeveral days, according to the quality of the calamine; during which time the zinc riſes in vapor from the calamine, unites with the copper, and renders that metal fuſible by conſiderably leſs heat than it is alone. To render the metal very fluid, that it may flow into one uniform maſs at the bottom, the fire is to be encreaſed a little before the crucibles are taken out for the pouring of the fluid metal into moulds. From ſixty pounds of good calamine and forty pounds of copper, ſixty pounds of braſs may by this proceſs be obtained, notwithſtanding that a conſiderable quantity of zinc is burnt and diſſipated during the operation; as we may learn from the blue flame round the mouths of the crucibles and furnaces, from the flowers of zinc which adhere to the inner ſides of the furnace, and from the blue color communicated to the crucibles. The quantity of braſs obtained has been conſiderably augmented ſince the introduction of the method now commonly practiſed of uſing granulated copper, by which a larger ſurface of this metal is expoſed to the vapor of the zinc, and conſequently leſs of that vapor eſcapes. For the granulation of the copper, a cylindrical wooden reſervoir is made, four or five feet deep, in which a circular braſs or copper bottom may be raiſed or lowered, by means of a chain. The reſervoir is covered with a copper lid, in the middle of which is a hole half a foot in diameter, intended to receive an iron ladle pierced with holes, and coated with clay. The reſervoir being filled with water, the melted copper is poured through the holes in the ladle into the water; where it is broken by its fall into ſmaller drops or grains, is rendered ment of animals; and amongſt grains thoſe which contain a farinaceous matter are the moſt agreeable and moſt nutritive.

Man, who appears to be deſigned by nature to eat of all ſubſtances which are capable of nouriſhing him, and ſtill more of vegetables than animals, has, from time immemorial, and in all parts of the earth, uſed farinaceous grains as the principal baſis of his food: but as theſe grains cannot be without difficulty eaten by men in their natural ſtate, this active and intelligent animal has gradually found means not only to extract the farinaceous part, that is, the only nutritive part of theſe grains, but alſo to prepare it ſo that it becomes a very agreeable and wholeſome aliment, ſuch as the bread we now generally eat.

Nothing appears ſo eaſy at firſt ſight as to grind corn, to make a paſte with the flour and water, and to bake this paſte in an oven. They who are accuſtomed to enjoy the advantages of the fineſt human inventions, without reflecting on the labor it has coſt to compleat them, think all theſe operations common and trivial. However, it appears very certain, that for a long time men no otherwiſe prepared their corn than by boiling and forming compact, viſcous cakes, not very agreeable to the taſte, and of difficult digeſtion, before they were able to make bread of good taſte and quality, as we have now. It was neceſſary to invent and compleat ingenious machines for grinding corn, and ſeparating the pure flour with little trouble and labor; and that inquiries, or rather ſome happy chance, which ſome obſerving perſon availed himſelf of, ſhould diſcover that flour mixed with a certain quantity of water is ſuſceptible of a fermentation, which almoſt entirely deſtroys its viſcidity, heightens its taſte, and renders it proper to make a

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dered ſolid by the cold water, and is collected in the moveable bottom, which is afterwards to be raiſed by the annexed chain, that the granulated copper may be taken out.——The above is the proceſs generally employed for making braſs. But to make the finer and more malleable kinds of braſs, beſides the choice of pure calamine and pure copper, ſome manufacturers cement the braſs a ſecond time with calamine and charcoal, and ſometimes add to it old braſs, by which the new is ſaid to be meliorated.

Braſs is brittle when hot, but is ſo ductile when cold that it may be drawn into very fine wire. Its beautiful color, its hardneſs, its malleability, its fuſibility, by which it may be eaſily caſt into moulds, and its quality of being leſs ſubject to ruſt or verdigriſe than copper, render it fit for the fabrication of many utenſils.

light bread, very agreeable to the taſte, and of eaſy digeſtion.

This eſſential operation, on which the good quality of bread depends, is entirely of the province of chemiſtry. It would add to the honour of the ancient cultivators of chemiſtry, to attribute to them ſo uſeful and important a diſcovery; but unhappily it is too probable that they had no ſhare in it. The ancient chemiſts were engaged in other purſuits than that of bread and other common objects. They hoped to make gold; and what is bread in compariſon with gold?

However that be, to the fortunate invention of raiſing the paſte before baking we owe the perfection of the art of making bread. This operation conſiſts in keeping ſome paſte or dough, till by a peculiar ſpirituous fermentation it ſwells, rarefies, and acquires a ſmell and taſte quick, pungent, ſpirituous, ſomewhat ſour, and rather diſagreeable. A ſmall quantity of this fermented dough is well worked with ſome freſh dough, which is by that mixture, and moderate heat, diſpoſed to a ſimilar, but leſs advanced fermentation than that above-mentioned. By this fermentation the dough is attenuated and divided, air is introduced into it, which being incapable of diſengaging itſelf from the tenacious and ſolid paſte, forms in it ſmall cavities, raiſes and ſwells it: hence the ſmall quantity of fermented paſte which diſpoſes the reſt to ferment, is called *leaven*, from the French word *lever*, ſignifying to raiſe.

When the dough is thus raiſed, it is in a proper ſtate to be put into the oven, where, while it is baked, it dilates itſelf ſtill more by the rarefaction of the air, and of the ſpirituous ſubſtance it contains, and it forms a bread full of eyes or cavities, conſequently light, and entirely different from the heavy, compact, viſcous, and indigeſted maſſes made by baking unfermented dough.

The invention of beer, or wine of grains, furniſhes a new matter uſeful in the making of bread. This matter is the froth which forms upon the ſurface of theſe liquors during fermentation. When it is mixed with dough, it raiſes it better and more quickly than ordinary leaven. It is called *yeaſt* or *barm*. By means of this the fineſt, lighteſt bread is made. It often happens that bread made with leaven dough has a ſouriſh and not agreeable taſte, which may proceed from too great a quantity of leaven, or from leaven in which the fermentation has advanced too far. This inconvenience does not happen to bread made with yeaſt;

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becauſe the fermentation of this ſubſtance is not too far advanced, or becauſe more attention is given to that finer bread.

It may be aſked, why, ſince dough is capable of fermenting ſpontaneouſly and ſingly, as we ſee from the leaven, a ſubſtance is added to diſpoſe it to ferment. The true reaſon is, that all the parts of a fermenting ſubſtance do not ferment at the ſame time, nor to the ſame degree; ſo that ſome parts of this ſubſtance have finiſhed their fermentation while others have not yet begun. The fermentable liquors which contain much ſugar, as hydromel, and muſt of wines, give proofs of this truth; for, after theſe liquors have become very vinous, they have ſtill very diſtinctly a ſaccharine taſte: but all ſaccharine matter is ſtill ſuſceptible of fermentation; and, in fact, if vinous hydromel, or muſt, or even new beer, be diſtilled, ſo that all their ardent ſpirit ſhall be ſeparated, and the reſiduums diluted with water, we ſhall ſee a ſecond fermentation take place, and a new quantity of ardent ſpirit formed.

The ſame thing preciſely happens to dough, and ſtill more ſenſibly, from its viſcoſity and want of fluidity; ſo that if it be left to ferment alone, and without the help of leaven, as the fermentation proceeds very ſlowly and ſucceſſively, the parts which ferment firſt will have become ſour and vapid before all the reſt be ſufficiently attenuated and changed, by which the bread will acquire a diſagreeable taſte.

A mixture of a ſmall quantity of leaven with dough effectually prevents this inconvenience; becauſe the effect of this leaven, and of all fermenting ſubſtances, is to diſpoſe to a ſimilar fermentation all matters capable of it, with which it is mixed; or rather, by means of leaven, the fermentation of all the parts of ſuch ſubſtances is effected more nearly at the ſame time.

Bread well raiſed and baked differs from unfermented bread, not only in being leſs compact, lighter, and of a more agreeable taſte, but alſo in being more eaſily miſcible with water, with which it does not form a viſcous maſs; and this circumſtance is of great importance in digeſtion.

BRONZE. Bronze is a compound of copper and tin, to which ſometimes other metallic ſubſtances, particularly zinc, are added.

Bronze is brittle, hard, and ſonorous. It is employed for various uſes, as for making bells, cannons, and ſtatues; and the proportions of the component metals are varied to ſuit the ſeveral uſes to which it is applied.

The compound of copper and tin has a greater than the intermediate ſpecific gravity. Two ounces of a metal compoſed of four-fifths of pure copper, and one fifth of pure tin have ſeven grains and the tenth of a grain more of ſpecific gravity, than the ſame quantities of theſe two metals not allayed have. *(m)* This proves that in the union of copper and tin there is a penetration of parts; that is, that one metal enters into the pores of the other. Perhaps even this effect is reciprocal.

Many chemiſts, and particularly Glauber and Becker, have a long time ago remarked, that the ſpecific gravities of metallic allays differed more or leſs from what they ought to be, if there were no penetration, and that ſometimes the effect is contrary. But lately this matter has been treated with more preciſion. Several good chemiſts, ſuch as Eiſporn, Hahn, Krafft, and Gellert, have given reſults of well conducted experiments on this ſubject. *See Gellert's Metallurgic Chemiſtry. See the words* ALLAY, GRAVITY (SPECIFIC).

Mr. Tillet, member of the Royal Academy of Sciences, obſerves, in his Memoir concerning the ductility of metals, that when the mixture of copper with tin is made in the proportions above-mentioned, the color of the copper is entirely annulled and covered by that of the tin, although the quantity of copper be four times the quantity of tin. This ſingular effect cannot be underſtood without admitting a total change in the ſize and diſpoſition of the pores of the compound metal; which conſequently is a new proof of the reciprocal penetration of the two metals.

As tin is leſs ſenſible to the action of ſalts, of moiſture, and of the air, than copper, it is alſo leſs liable to ruſt: hence bronze is leſs apt to be covered with verdigriſe than pure copper is. This is one reaſon why this allay is uſed for cannons, ſtatues, and works expoſed to the air and weather.

(m) The author means, I ſuppoſe, that a metallic maſs, weighing two ounces, compoſed of four fifths of copper and one fifth part of tin, weighs, in water, $7\frac{1}{10}$ grains more than the ſame quantites of theſe two metals would together weigh, in water, if not allayed.

The greater fuſibility of bronze than of copper is alſo an advantageous property, and much facilitates the caſting of large works, as ſtatues, bells, and cannon.

Laſtly, a phenomenon worthy of attention is, that tin, though greatly ſofter and leſs ſonorous than copper, nevertheleſs renders this metal, by being allayed with it in a proper proportion, more hard and more ſonorous: hence this allay is uſed for bells.

The operation by which large works of bronze are caſt is ſufficiently ſimple. For this purpoſe a brick furnace is uſed, nearly the ſhape of an oven for baking bread. The floor of this furnace is concave, and conſiſts of a compoſition of ſand and clay. In this hollow floor the metals to be fuſed are put. The furnace has three openings.

The firſt is a lateral mouth, at which enters the flame of wood placed in a ſecond furnace on one ſide of the firſt: the ſecond opening is a chimney placed on the ſide oppoſite to the mouth, by means of which the flame is drawn over the metal. The third opening is a hole which is opened and ſhut at pleaſure, through which the inner part of the furnace may be occaſionally inſpected, that the ſtate of the metal may be obſerved. When the metal is in the ſtate required, a fourth opening is then uncloſed, communicating with the hollow floor, and through which the melted metal flows by channels into the moulds prepared to receive it.

BUTTER. Butter is the fat, oily, and inflammable part of milk. This kind of oil is naturally diſtributed through all the ſubſtances of the milk, in very ſmall particles, which are interpoſed betwixt the caſeous and ſerous parts, amongſt which it is ſuſpended by a ſlight adheſion, but without being diſſolved. It is in the ſame ſtate in which oil is, in emulſions; hence the ſame whiteneſs of milk and emulſions, and hence by reſt the oily parts ſeparate from both theſe liquors to the ſurface, and form a cream. *See* EMULSION.

When butter is in the ſtate of cream, its proper oily parts are not yet ſufficiently united together to form a homogeneous maſs. They are ſtill half ſeparated by the interpoſition of a pretty large quantity of caſeous and ſerous particles. The butter is compleatly formed by preſſing out theſe heterogeneous parts by means of continued percuſſion. It then becomes an uniform ſoft maſs.

Freſh butter, which has undergone no change, has ſcarcely any ſmell; its taſte is mild and agreeable, it melts with a weak heat, and none of its principles are diſengaged by the heat of boiling water. Theſe properties, together with that of not inflaming but with a heat greater than that of boiling water, capable of decompoſing it, and reducing it to vapors, prove that the oily part of butter is of the nature of the mild, fat, and fixed oils obtained from many vegetable ſubſtances by expreſſion. *See* OILS (SWEET EXPRESSED).

The half fluid conſiſtence of butter, as of moſt other concrete oily matters, is cauſed by a conſiderable quantity of acid, united with the oily part: but this acid is ſo well combined, that it is not ſenſible while the butter is freſh, and has undergone no change; but when it grows old, and undergoes ſome kind of fermentation, then the acid is diſengaged more and more; and this is the cauſe that butter, like oils of the ſame kind, becomes rancid by age.

The acid of butter is more quickly and ſenſibly diſengaged by fire. If butter be expoſed to a degeee of fire ſtrong enough to make it ſmoke, vapors are exhaled from it inſupportably acrid, which draws tears from the eyes, and excite coughing, as may be daily obſerved in kitchens. Theſe vapors are nothing elſe than the diſengaged acid. The remaining part of the butter after this operation has a ſtrong taſte, very different from its former mildneſs; becauſe the part of the acid which is not exhaled is become ſenſible and half-diſengaged by the action of the fire. The ſame thing preciſely happens when butter is diſtilled in a retort.

To decompoſe butter by diſtillation, a much greater heat than that of boiling water muſt be applied to it: acid vapors are then raiſed of conſiderable volatility and acrimony. Theſe vapors are accompanied with a ſmall portion of oil, which being that part which is moſtly deprived of its acid, does not congeal; then a ſecond oil of a red color paſſes, which congeals when cold, and which becomes more and more thick as the diſtillation advances. Laſtly, a ſmall quantity of charry matter remains in the retort, which in an open fire can be ſcarcely burnt entirely, and reduced to aſhes.

If the congealed oil in the receiver be again diſtilled, more acid and fluid oil are obtained. Thus the whole of it may be reduced into acid and fluid oil by repeated diſtillations.

The acid obtained is accompanied with phlegm, particularly at firſt, and with a portion of oil united with it, which it renders ſoluble in water, and to which it partly owes its volatility. It is owing to this oil that the acid has the empyreumatic ſmell of burnt butter.

There are many eſſential remarks to be made upon this analyſis of butter by diſtillation; becauſe it preſents exactly the ſame phenomena as the analyſis of all other concrete oily matters of the ſame kind, ſuch as wax, ſuet, cacao butter, ſperma-ceti, and may be conſidered as a ſpecimen of the decompoſition of all theſe matters.

Firſt, it is neceſſary that theſe diſtillations ſhould be made ſlowly, and with the preciſe degree of heat neceſſary for continuing a moderate diſtillation; becauſe when the diſtillation is too much hurried, the acid has not time to ſeparate itſelf, and the concrete oily matter paſſes almoſt entirely into the receiver without ſuffering any decompoſition: but whatever management be employed, a conſiderable part of this half-decompoſed matter always paſſes, which muſt be ſubjected to future diſtillations in order to reduce it to fluid oil.

Secondly, when the diſtillation is too much hurried, the acid paſſes in white ſenſible vapors from the quantity of oil united with it. For the ſame reaſon, towards the end of the diſtillation, when the fire muſt be raiſed, the acid always paſſes in this form of white ſenſible vapors.

Thirdly, at each diſtillation of butter, or of its congealed oil, there is always a portion of oil entirely decompoſed; and thus the quantity continually diminiſhes, and ſenſibly.

This quantity of entirely decompoſed oil is proportionable to the quantities of phlegm, acid, charry reſiduum, or earthy phlogiſticated matter, which are obtained at each diſtillation, and are the proximate principles of the oil. This remark is applicable to the diſtillation of any oil. *See* OIL.

We ought alſo to obſerve in general upon this analyſis of butter, that this matter, although derived from animal bodies, does not yield a particle of volatile alkali; neither does the fat of animals; which proves that theſe ſubſtances are not aſſimilated to other animal ſubſtances, all which, when decompoſed, furniſh volatile alkali, without excepting the oils obtained from theſe ſubſtances.

Butter is conſtantly uſed in food, from its agreeable taſte; but to be wholeſome, it muſt be very freſh, and free from rancidity, and alſo not fried or burnt; otherwiſe its acrid and even cauſtic acid being diſengaged, diſorders digeſtion, renders it difficult and painful, excites acrid, empyreumatic belchings, and laſtly, introduces much acrimony into the blood. Some perſons have ſo delicate ſtomachs, that they are even affected with theſe inconveniences by freſh butter and by milk. *See* MILK. This obſervation is alſo applicable to oil, to fat, to chocolate, and in general to all oleaginous matters.

BUTTER *of* ANTIMONY. Butter of antimony, called by ſome chemiſts the *glacial oil of antimony*, is compoſed of marine acid united with the reguline part of antimony.

This is one of the combinations which cannot be made directly; that is, by the application of pure and liquid marine acid to the regulus of antimony; for in this manner the marine acid, however ſtrong, diſſolves none, or almoſt none, of the regulus: but when the acid is in its higheſt degree of concentration, reduced almoſt to dryneſs, as it is in ſeveral combinations, and when the body to which it is united has a weaker affinity to it than the regulus of antimony has, then it quits that body to unite with the regulus, and forms the butter of antimony.

Marine acid united with mercury has all the above-mentioned conditions; wherefore butter of antimony may be made by mixing together corroſive ſublimate and regulus of antimony, both well powdered, and by applying a certain heat and diſtillation.

Lemeri, the moſt exact of the operators who have written, ſays, that the beſt proportion of corroſive ſublimate and regulus of antimony is ſixteen parts of the former to ſix parts of the latter. He obſerves, that this mixture frequently becomes very hot, ſome time after it has been made. This heat proceeds from the re-action of the two matters upon each other even without fire.

To proceed to the diſtillation of butter of antimony: this mixture muſt be put in a retort of convenient ſize, the neck of which ought to be large and ſhort; this retort is to be placed in a furnace with a ſand-bath; a receiver is to be luted, and the diſtillation is to be carried on at firſt by a gentle fire, which is to be encreaſed as more heat becomes neceſſary to continue the operation; a heavy liquor riſes, which congeals in the receiver when it cools; this is the butter of antimony. The operation is ſtopped when it appears that it cannot be continued without a great encreaſe of heat, by which fluid mercury would be diſtilled inſtead of butter of antimony.

If then it be required to obtain this mercury, which is a very pure mercury, revived from corroſive ſublimate, before

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the fire is encreaſed, it is proper to remove the receiver, and apply another containing ſome water.

It is evident, that as the marine acid only unites with the regulus of antimony by diſengaging itſelf from the mercury of the corroſive ſublimate, this latter metal ought to appear in its proper fluid form; but as it is leſs volatile than the butter of antimony, it does not riſe till this has paſſed, and the fire be encreaſed.

Butter of antimony may alſo be made by uſing antimony itſelf inſtead of its regulus; becauſe the acid of corroſive ſublimate attacks as eaſily the regulus of antimony in the antimony itſelf, although it be there united with ſulphur, as when it is pure: but it is evident, that in this caſe more antimony muſt be uſed, than the requiſite quantity of regulus in the preceding operation. Lemeri obſerves, that twelve parts of antimony are neceſſary for ſixteen parts of corroſive ſublimate.

When butter of antimony is made by this latter method, it more readily congeals, and is more ſolid than when made with the regulus.

Mr. Baron, in his notes on Lemeri's Chemiſtry, ſays, that this proceeds from the greater quantity of acid contained in the butter made with the regulus than in that made with antimony. This matter would require a particular examination.

However that may be, a part of this butter made with antimony always congeals in the neck of the retort, and is frequently accumulated there in ſufficient quantity to block up the paſſage, by which means the confined vapors may occaſion an exploſion. This inconvenience is prevented by applying a hot-coal near the neck of the retort, by which the butter is melted, and made to flow into the receiver.

It is evident, that when the butter of antimony is made with antimony, if the diſtillation be continued after the butter has paſſed, we ſhall not then obtain fluid mercury, but a combination of mercury with the ſulphur of the antimony, that is, a cinnabar will be ſublimed. This is called the *cinnabar of antimony*. *See* MERCURY, SULPHUR, *and* CINNABAR.

This cinnabar makes its appearance towards the end of the operation by red vapors. As ſoon as theſe are ſeen, the receiver ought to be changed.

The butter of antimony made by either of theſe operations, eſpecially by the latter, is generally rendered more or leſs impure by ſome fluid mercury, or by ſome cinnabar, which are raiſed along with it: but it is eaſily purified from theſe extraneous ſubſtances by a ſecond diſtillation with a gentle heat, when it paſſes very white and pure. This ſecond diſtillation, as all other repeated diſtillations and ſublimations for the purifying of ſubſtances, is called *rectification.*

Sweet ſublimate, *mercurial panacea*, and *white precipitate*, are alſo mercurial combinations with marine acid; and, like the corroſive ſublimate, are capable of being decompoſed by means of regulus of antimony, and of forming with it kinds of butter of antimony. But Lemeri obſerves, that theſe butters are leſs cauſtic than that made with corroſive ſublimate; undoubtedly, becauſe theſe mercurial compounds contain leſs marine acid.

Laſtly, butter of antimony may be made with *luna cornea*, which is a combination of ſilver with very concentrated marine acid, which is nearly in the ſame ſtate as it is in corroſive ſublimate, (*ſee* LUNA CORNEA); becauſe the marine acid has leſs affinity with ſilver than with regulus of antimony. This butter is called the *lunar butter of antimony.*

Butter of antimony then contains a very concentrated marine acid, which is not ſo intimately engaged with the regulus of antimony as to loſe all its properties; hence we may account for the property which the butter of antimony has of attracting moiſture from air, and for its cauſticity; for it is ſtrongly corroſive, and is applied, like lapis infernalis, to ulcers and to carious bones. *See* CAUSTICITY.

This metallic ſalt has been called *butter*, from its conſiſtence, which is nearly the ſame as that of butter, and from the facility with which it melts with a very gentle heat.

Butter of antimony ought to be claſſed amongſt the ſalts which are at once cryſtallizable and deliqueſcent; for however confuſed the maſs ſeems after diſtillation, it is in fact a heap of very ſmall cryſtals.

By the operation of butter of antimony, and its properties, ſeveral eſſential properties of the marine acid and of regulus of antimony are diſcovered.

Firſt, although the marine acid has a great affinity with this ſemi-metal, it cannot diſſolve it, but when highly concentrated. This phenomenon is analogous to thoſe preſented by the marine acid with mercury and with ſilver, to both which it has a great affinity, but which it cannot diſſolve unleſs it be very highly concentrated, or applied to them when their aggregation is broken; as we ſee by the operations of making *white precipitate*, *corroſive ſublimate*, *luna cornea*, and of the *concentrated parting*. *See all theſe words.*

Secondly, the property which the butter of antimony has of not being decompoſed by fire alone, as the metallic ſalts are which contain the vitriolic and nitrous acids, depends on the great adheſion which the marine acid contracts with the regulus of antimony, as it generally does with other metallic matters, and on its property of volatilizing them, or carrying them along with it in diſtillation; which we ſee happens in corroſive ſublimate, luna cornea, ſmoking ſpirit of Libavius, and many other chemical operations, in which the moſt fixed metals are carried off by marine acid.

Thirdly, the butter of antimony is by the affuſion of water changed in its nature, or rather is divided into two parts, one of which is perfectly diſſolved by the water, and another part is precipitated, being inſoluble by water. The diſſolved part contains its greateſt poſſible quantity of acid, and the precipitated part contains the leaſt poſſible quantity of acid. This latter part, when well waſhed, is called *mercurius vitæ*, or *powder of algaroth*. *See* POWDER *of* ALGAROTH.

Mr. Beaumé pretends, that the powder of algaroth is improperly ſaid to contain the leaſt poſſible quantity of acid, ſince, by a ſufficient lavation, he has been able to deprive it of every veſtige of an acid.

Butter of antimony is ſoluble in nitrous acid; and this ſolution is made with great violence: afterwards, by evaporation of the acids, a white calx of antimony is formed, called *Bezoar mineral*. *See that word.*

BUTTER *of* ARSENIC. Butter of arſenic, called alſo *corroſive oil of arſenic*, is a combination of marine acid with arſenic. This combination is made by a proceſs ſimilar to that of the butter of antimony. According to Lemeri, equal parts of butter of arſenic and corroſive ſublimate ought to be pulveriſed, well mixed, and diſtilled together; by which a butyraceous liquor is obtained ſimilar to butter of antimony in its external appearance.

When the diſtillation cannot be continued without conſiderably encreaſing the fire, the receiver ought to be taken off, and another receiver, in which there is ſome water, adapted to the retort; then, upon raiſing the fire, fluid mercury may be obtained. *See* BUTTER *of* ANTIMONY.

This experiment ſhews that the affinity of marine acid to arſenic is greater than to mercury. In this operation the mercury is revived from the corroſive ſublimate.

It is evident that this butter of arſenic muſt be a moſt violent cauſtic. It ought not to be ever uſed, from its poiſonous quality. *See* ARSENIC.

It does not appear that this combination of marine acid with arſenic has beeen carefully examined by any chemiſt.

BUTTER *of* CACAO. Butter of cacao is an oily, concrete, white matter, of a firmer conſiſtence than butter, or even than ſuet. This ſubſtance is extracted from the kernel of a fruit called *cacao*, with which *chocolate* is made.

As the butter of cacao is a true congealed oil, it cannot be obtained without a heat ſufficient to melt it. The beſt method is to bruiſe the cacao, and to boil it in water. Almoſt all the ſuperabundant and uncombined oil, which this ſubſtance contains, is liquified, and ſeparated from the parenchyma and extractive part; and as it is lighter, it ſwims on the ſurface of the liquor in which it is left to congeal, that it may more eaſily be taken off. This butter is generally mixed with ſome broken ſolid bits of the cacao fruit, from which it may be purified by melting with a very gentle heat without water, in a pretty deep veſſel, and by keeping it thus melted, long enough for an entire ſeparation of the matters to take place according to their ſpecific gravities. By this method, a very white and pure butter of cacao may be obtained.

This oily concrete ſubſtance has a very mild taſte; it has no aromatic ſmell; it does not riſe in diſtillation without a heat ſuperior to that of boiling water; by diſtillation it is partly decompoſed; laſtly, it does not flame, till it is ſufficiently heated to be reduced into vapors. As theſe are preciſely the properties of mild and fat oils obtained from vegetable and animal matters by expreſſion only, the butter of cacao muſt be undoubtedly ranged in this claſs; and as it is concrete, it is analogous to other concrete oily matters of the ſame nature, ſuch as wax, fat, butter of milk, &c. It alſo preſents the ſame phenomena as theſe ſubſtances do, when decompoſed and attenuated by diſtillation; for which reaſon, *ſee* BUTTER.

Butter of cacao has quite the ſame medicinal properties as all the mild expreſſed oils. It is emollient and blunting when not rancid; it enters into the compoſition of pomatums. *See* OILS (SWEET EXPRESSED).

BUTTER *of* WAX. Butter of wax is nothing but half-decompoſed wax; that is, wax deprived of a part of its acid by diſtillation. As this acid is the cauſe of the conſiſtence of the oily part of wax, the reaſon is evident why the butter is ſofter than the wax itſelf. It has a ſtrong ſmell, and, when left expoſed to the air, it does not reſume its conſiſtence, in which it eſſentially differs from reſinous matters. *See* WAX.

BUTTER *of* TIN. *Butter of tin* is a name given by ſome chemiſts to a combination of tin with the concentrated marine acid of corroſive ſublimate.

Tin, as well as the regulus of antimony, has a ſtronger affinity to marine acid than mercury has. If therefore corroſive ſublimate and tin, reduced to ſmall parts, be mixed together, theſe two ſubſtances will act upon each other even without the application of heat, ſo that in time the mixture becomes moiſt, and attracts the humidity of the air. If theſe ſubſtances be diſtilled together immediately after their mixture, the corroſive ſublimate is much more quickly decompoſed by the tin; the marine acid quits the mercury to unite with the tin, the greateſt part of which it carries off along with it. In this diſtillation a kind of *marine ſalt with baſis of tin* paſſes over. Part of this combination is in form of a liquor which ſmokes continually, even when cold. This is called the *ſmoking ſpirit of Libavius.* Another part is raiſed in a concrete form, which more particularly deſerves the appellation of *butter of tin*, although it ſeems that ſeveral chemiſts give this name indifferently to the liquor or concrete matter, or to both of them at the ſame time. *See* SPIRIT (SMOKING) *of* LIBAVIUS.

BUTTON. By the word *button*, is meant the metal which is collected generally in a roundiſh maſs at the bottom of a crucible after fuſion, or which remains in the cupels after cupellation.

CADMIA. The name of *Cadmia*, or *Calamine*, is given to ſeveral different ſubſtances. What is called the *Cadmia of the furnaces* is a matter which is ſublimed when ores containing zinc, like thoſe of Rammelſberg, are ſmelted. This cadmia conſiſts of the flowers of zinc ſublimed during the fuſion, and adhering to the inner ſurfaces of the walls of furnaces, where they ſuffer a ſemi-fuſion, and therefore acquire ſome ſolidity. So great a quantity of theſe are collected, that they form very thick incruſtations, which muſt be frequently taken off. The name of *Cadmia of furnaces*, has alſo been given to all the ſoots and metallic ſublimates formed by ſmelting in the great, although there certainly are great differences in theſe matters. *See* SMELTING *of* ORES.

Several authors call *Native* or *Foſſil Cadima*, a ſort of ſtone or mineral, containing zinc, iron, and ſometimes other ſubſtances. It is of a yellow or reddiſh color, and is alſo called *Calamy*, *Calamine*, or *lapis calaminaris*. Both this mineral and the *Cadmia of Furnaces* are uſed for the preparation of braſs. *See* BRASS.

Laſtly, ſome chemiſts have given the name of *Foſſil Cadmia* to a mineral containing arſenic, frequently biſmuth, ſilver, and particularly the ſemi-metal, the calx of which being melted with vitrifiable matters, forms a beautiful blue glaſs. This mineral is better known by the name *Cobalt*, which alone ought to be given to it, to avoid the confuſion attending the application of the ſame name to different ſubſtances. *See* COBALT.

CALAMINE. *See* CADMIA, *and* ORES *of* ZINC.

CALCINATION. The calcination of a body is, properly ſpeaking, the expoſing of it to the action of fire, to produce ſome change upon it.

The principal effects of fire in chemical operations are to carry off the volatile principles, and to ſeparate them from the fixed, or to occaſion the combuſtion of inflammable matters. Hence it follows that bodies are calcined either to deprive them of ſome volatile principle, or to deſtroy their inflammable principle, and ſometimes for both of theſe purpoſes.

We have examples of the firſt kind of calcination, in expoſing calcareous earths and ſtones to the fire, to convert them into quicklime, which is effected by the entire evaporation of the watery principle contained in this kind of earth. *See* QUICKLIME.

The calcination of *Gypſum*, of *Alum*, of *Borax*, and of ſeveral other *Salts*, by fire, which deprives them of the water neceſſary for their cryſtallization; the roaſting of minerals, by which the fire carries off the ſulphur, arſenic, and other volatile contents; ought to be referred to the firſt kind of calcination.

We have an example of the ſecond kind of calcination, by expoſing imperfect metals to fire; by which they loſe their inflammable principle, their form, and metallic properties,

perties, and are changed into earthy matters called *Metallic Calxes.*

It is neceſſary to obſerve, that this ſecond calcination differs eſſentially from the firſt, as the changes produced by it upon imperfect metals are not effected by evaporation, but by decompoſition and deſtruction of their phlogiſton. It is therefore a *combuſtion*, and not a *volatiliſation* of their inflammable principle.

Hence it follows, that the firſt kind of calcination may ſucceed without the contact of air and in cloſe veſſels, although it is more quick and complete in open veſſels, from a property of air, by which it greatly accelerates the evaporation of volatile bodies. *See* AIR. But as the ſecond kind of calcination is a true combuſtion, like that of all inflammable bodies, it requires all the conditions neceſſary for combuſtion, and particularly the free acceſs of air. *See* COMBUSTION *and* CALXES (METALLIC).

There are many bodies, in the calcination of which an evaporation of volatile parts happens, and alſo a deſtruction or deprivation of their inflammable principle, although without any ſenſible combuſtion of this latter. Such particularly are all combinations of imperfect metallic matters with vitriolic and nitrous acids: when theſe bodies are expoſed to fire, their acid evaporates, and at the ſame time carries off with it their inflammable principle. We have examples of this kind of calcination in expoſing to fire *Martial Vitriol* and *Bezoar Mineral.*

As vitriolic acid, and ſtill more nitrous acid, deprive the imperfect metals of more or leſs of their phlogiſton even without fire, ſeveral of theſe metals, particularly iron, copper, tin, regulus of antimony, are reduced, after they have been diſſolved in theſe acids, to a ſtate ſimilar to that of calcination with acceſs of air; that is to ſay, they become earths, not poſſeſſed of metallic properties, which they cannot reſume without the addition of phlogiſton. Hence moſt chemiſts conſider acids as capable of calcining theſe metals, and they accordingly call earths of metals which have been dephlogiſticated by acids, without fire, *Calxes.*

Laſtly, nitrous acid, when engaged in a fixed alkali, that is, nitre having the property of inflaming when applied to a combuſtible ſubſtance with a red heat, and of making the phlogiſton of theſe bodies burn, becomes a very powerful agent for the calcination of many ſubſtances, and particularly of imperfect metals and charry matters. *See* NITRE.

We have a very good example of this kind of calcination in the preparation of diaphoretic antimony.

This calcination of metals by nitre is effected partly by a dephlogiſtication ſimilar to that by nitrous acid in humid ſolutions, and partly by combuſtion: which does not hinder it from ſucceeding without acceſs of air, and in cloſe veſſels, from the peculiar property of nitre in this reſpect. *See* NITRE.

It is proper to obſerve, that certain preparations of gold and ſilver are improperly called calxes, becauſe they are not truly calcined, no method being known by which they can be deprived of their phlogiſton. *See* GOLD, SILVER, *and* METALS (PERFECT).

What is improperly called *Calx of Gold*, is nothing but gold reduced into very fine particles, either by amalgamation with mercury, or by its ſeparation from other ſolvents. Moſt of theſe improper names, found in ſuch numbers in chemiſtry, proceed from the ignorance of ancient chemiſts, and ſtill more of alchemiſts, who all believed, for example, that they had proceſſes for decompoſing and calcining gold. Nothing is more equivocal than the pretended calcinations of perfect metals. We cannot, however, affirm its impoſſibility. Some facts even ſeem to make it probable; ſuch as the deſtruction of gold in the focus of Thirſnhauſen's great lens, an account of which is publiſhed by Homberg in the Memoirs of the Academy of Sciences, and the calcination of gold by long reverberation, in the manner of Iſaacus Hollandus. But if the moſt ſimple and eaſy experiments of chemiſtry require frequent repetition to be ſufficiently eſtabliſhed, certainly theſe, which are exceedingly difficult and laborious, require great attention. *See* COMBUSTION, *for ſome eſſential obſervations regarding the ſecond kind of calcinatian.*

CALXES *of* METALS. Metallic calxes are earths of metals deprived of their phlogiſton, and conſequently of their metallic properties.

All metallic ſubſtances, excepting gold, ſilver, platina and mercury, are ſuſceptible of being deprived of their inflammable principle by ſeveral methods.

The firſt method is by burning their phlogiſton in open air, and by a calcination, or rather a combuſtion ſimilar to that of all other combuſtible matters. *See* CALCINATION *and* COMBUSTION.

The ſecond method is by applying to metals acids capable of depriving them of their phlogiſton, ſuch as vitriolic acid, and particularly nitrous acid. This kind of calcination of metals is made in the humid way, and by ſolution. *See* SOLUTION.

The third method is by nitre, with which metallic matters may be detonated. This third method, which is compoſed of the two former, is the moſt efficacious and expeditious. *See* NITRE, *and* DETONATION *of* NITRE.

The earths of metals deprived of phlogiſton by any of theſe methods have properties peculiar to each, concerning which the articles of the ſeveral metallic ſubſtances ought to be conſulted; but they alſo have properties general and common to all. Theſe are the following:

Not only calcined metals loſe the characteriſtic properties of metals, but alſo the following changes are effected. The more perfectly metallic matters are calcined, the more they loſe of their fuſibility; ſo that very fuſible ſubſtances, ſuch as tin and regulus of antimony, are rendered by a perfect calcination, (that is, till they become very white) bodies abſolutely infuſible, and which may be claſſed amongſt thoſe that are refractory. Hence it is proved that phlogiſton is the principle of fuſibility of metals.

In proportion as metallic ſubſtances loſe their phlogiſton, they become more fixed. This property is leſs ſenſible in metals, from their fixity, than in ſemi-metals, all which are very volatile when in their metallic ſtate, and the calxes or earths of which become exceedingly fixed, as we ſee very evidently from the example of diaphoretic antimony, which reſiſts the moſt violent fire without the leaſt loſs, and which recovers all its volatility, if it be reſtored to its reguline ſtate by addition of phlogiſton. This proves that phlogiſton is a principle eſſentially volatile, and that it communicates its volatility to certain bodies with which it is combined.

Metallic earths become leſs ſoluble in acids, and particularly in nitrous acid, by being deprived of phlogiſton, as we may perceive from crocus martis when well calcined, from calxes of tin, of regulus of antimony, &c. Hence we are led to conclude, that the ſolubility of metallic ſubſtances by acids, and particularly by nitrous acid, depends on the intervention of phlogiſton: for if calxes be reduced by adding phlogiſton, the metals reſulting from that reduction will then recover their ſolubility.

What we have ſaid concerning the general changes produced by calcination of metallic matters, upon their fuſibility, their fixity, and ſolubility, may alſo be applied to their opacity, their ſpecific gravity, in a word, to all their metallic properties, which are always diminiſhed ſo much more in metallic calxes, as they are more perfectly dephlogiſticated. This ſeems to indicate, that if an entire and perfect calcination of metallic ſubſtances could be effected, they would then have no metallic property, and perhaps they would not ſpecifically differ from each other, and only be one and the ſame kind of earth. This is certain, that when the calcination of metals has been too long continued, their calxes become irreducible, or at leaſt much more difficultly reducible; and this reduction is always made with loſs, ſo that the quantity of metal originally calcined is never again obtained.

Although metallic calxes are eſſentially different from calx of ſtone or quicklime, they have nevertheleſs ſome ſimilar properties, particularly thoſe which relate to fixed and volatile alkalis. Thus, for example, fixed alkalis receive from metallic calxes the ſame cauſticity and properties as from quicklime; and volatile alkali may be ſeparated from ſal ammoniac by metallic calxes, and particularly by minium, as it may by quicklime; and it receives the ſame changes, that is, it becomes more penetrating, is always fluid, and cannot be reduced to a concrete ſtate, when treated with a ſufficient quantity of theſe matters. *See* QUICKLIME.

CAMOMILE. *(o)*

CAMPHOR. Camphor is a vegetable, concrete, very volatile ſubſtance, and inflammable, as eſſential oils are; of a ſtrong ſmell, and eaſily ſoluble in ſpirit of wine.

From all theſe properties, camphor perfectly reſembles reſins; but on the other ſide, it eſſentially differs from them in this, that when expoſed to fire in cloſe veſſels, it is entirely ſublimed without ſuffering any decompoſition, and without leaving any reſiduum of coal or other matter. Although it has a ſtrong taſte, it has not the acrimony of eſſential oils: the moſt cauſtic alkalis do not act upon it: the vitriolic and nitrous acids diſſolve it, but without efferveſcence,

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(o) CAMOMILE. In the cup of the flowers of camomile reſides a ſmall quantity of blue eſſential oil. The flowers contain alſo a ſaline ſubſtance, which being extracted by decoction in wine, precipitated ſilver and mercury from nitrous acid, and theſe precipitates were different from luna cornea and corroſive ſublimate. *Neuman.* Camomile flowers have been found by Dr. Pringle's experiments to poſſeſs eminently an antiſeptic quality.

heat, inflammation, ſcorching, or other ſenſible change, even when theſe acids are concentrated.

Nitrous acid diſſolves camphor without commotion; and the ſolution is clear and limpid. It is called *Oil of Camphor*. When it is mixed with too much water, the mixture becomes turbid and milky, becauſe the acid has a ſtronger affinity with water than with camphor. The camphor then quits the acid, and appears in white flocks, which ſoon precipitate to the bottom of the containing veſſel, their weight being encreaſed by ſome adhering acid. But when this acid is taken off by the water, the flocks of camphor riſe to the ſurface, and there float. When they are compleatly waſhed and dried, they are found to be comphor entirely ſimilar to what it was before this ſolution and precipitation. This is a manifeſt proof that camphor receives no change from the nitrous acid; which, however, of all acids, acts the moſt powerfully upon oily matters. *See* OILS (ESSENTIAL) *and* RESINS, *for the reſemblances and differences betwixt camphor and theſe ſubſtances.*

It follows from what has been ſaid concerning the properties of camphor, that this ſingular ſubſtance, although it has many of the eſſential properties of oils and reſins, is not, however, comparable to any of thoſe which are known, and forms a claſs apart. As, excepting its concrete ſtate, camphor approaches more to the nature of ether, preciſely by thoſe very properties in which it differs from oils, it is to be preſumed that this ſubſtance is analogous to ether, as Mr. Macquer conjectures in his Elements of Chemiſtry. *See* ETHER.

All the camphor which is ſold comes from India and Japan. It is procured from a kind of laurel called *Laurus Camphorifera*, great numbers of which grow in the iſland Borneo. A long time this tree was believed to be the only vegetable containing camphor; but ſeveral modern chemiſts, and particularly Mr. Cartheuſer, have diſcovered, that many aromatic plants, as thyme, roſemary, ſage, and almoſt all the labiated kind, contain a ſubſtance of the nature of camphor, which may be extracted, although in very ſmall quantities.

Camphor when firſt extracted from its tree is mixed with many impurities, and is then called *Rough Camphor*. The Dutch, who chiefly make a trade of it, purify it by ſublimation in glaſs matraſſes.

Camphor is uſed in medicines as ſedative and antiſpaſmodic. It ſucceeds well in many convulſions, and other nervous affections. This quality is common to it, and to all other ethereal, oily, volatile ſubſtances, ſuch as *Ether*, *Dippel's Animal oil*, *highly rectified Eſſential Oils*, *Muſk*, *Caſtor*, *Opium*, and other ſimilar ſubſtances. Hoffman has obſerved and commended, more than any other phyſician, the ſedative powers of camphor. This ſubſtance is alſo very ſucceſsfully uſed as a powerful antiſeptic, and when diſſolved in ſpirit of wine, is employed againſt gangrenes.

CANTHARIDES. (p)

CAP. The piece which terminates the top of a melting furnace is called the *Cap*. This piece has the form of an oblong dome. In one ſide there is a large oval door, intended for the introduction of a conſiderable quantity of coal at a time, becauſe this kind of furnace conſumes a great deal, and muſt be quickly ſupplied. The upper part of the cap is terminated by a tube or chimney, which may be lengthened at pleaſure by the addition of other tubes adjuſted to each other. *See* FURNACE (MELTING).

CAPITAL. The *Capital* or *Head* is the upper part of an alembic. *See* ALEMBIC.

CAPUT MORTUUM. This is a Latin name given to fixed and exhauſted reſiduums remaining in retorts after diſtillations.

As theſe reſiduums are very different, according to the ſubſtances diſtilled, and the degree of heat employed, they ought to be ſpecified more particularly by adding a term denoting their qualities; as, for example, we might ſay, *Earthy Reſiduum*, *Charry Reſiduum*, *Saline Reſiduum*, &c. This method is more accurate and diſtinct, and is chiefly uſed by modern chemiſts.

CARDAMOM. (q)

CARDUUS. (r)

CARMINE

(p) CANTHARIDES. Theſe inſects contain a very acrid reſinous ſubſtance, ſix drams and two ſcruples of which were extracted by ſpirit of wine from four ounces of cantharides. The ſtimulating power of cantharides is cauſed by this ſubſtance, and not, as ſome imagine, by a volatile alkali, of which they yield leſs by analyſis than ſome other animal ſubſtances, and none without the action of fire. *Neuman.*

(q) CARDAMOM. An ounce of the ſeeds of the leſſer cardamom contain about a ſcruple of eſſential oil, by which their pungency and aromatic ſmell are cauſed, with fourteen grains of reſinous extract, and forty-five grains of mucilage. *Neuman.*

(r) CARDUUS BENEDICTUS. From four ounces of the leaves of this plant may be obtained about 4½ drams of reſinous extract

by

CARMINE. (*s*)

CARNELIAN. (*t*)

CASE-HARDENING. (*u*)

CASSIA. (*x*)

CASTOR. (*y*)

CAUSTIC (COMMON). Common cauſtic is a fixed alkaline ſalt, ſharpened by quicklime, and deprived of all moiſture by drying and fuſion. The alkali employed for this preparation is generally potaſh. A lixivium is made with quicklime, like that of the ſoap-boilers, called ſoap-leys. *See* LIXIVIUM *of* SOAP-BOILERS. This lixivium is to be evaporated to dryneſs in a copper or ſilver veſſel. Afterwards the dry matter is to be put into a crucible, and expoſed to fire till it flow like melted wax. Then it is to be poured into a baſon, and quickly cut into

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by means of ſpirit of wine; or from the ſame quantity of leaves, about 6½ of mucilaginous extract by means of water. In the juice of this plant, after proper depuration and evaporation, ſaline cryſtals ſimilar to tartar are formed. *Neuman*.

(*s*) CARMINE is a red pigment prepared by diſſolving cochineal in an alkaline lixivium, and precipitating the ſolution by alum. It conſiſts, therefore, of the coloring matter of cochineal adhering to the earth of alum.

(*t*) CARNELIAN, *Carneolus*, or *Sardus*, is a ſemi-tranſparent reddiſh agate. *See* AGATE.

(*u*) CASE-HARDENING of iron is a ſuperficial converſion of that metal into ſteel by the ordinary method of converſion, namely, by cementation with vegetable or animal coals. This operation is generally practiſed upon ſmall pieces of iron wrought into tools, and inſtruments, to which a ſuperficial converſion is ſufficient; and it may be performed conveniently by putting the pieces of iron to be caſe-hardened, together with the cement, in an iron box, which is to be cloſely ſhut and expoſed to a red heat during ſome hours. By this cementation, a certain thickneſs from the ſurface of the iron will be converted into ſteel, and a proper hardneſs may be afterwards given by ſudden extinction of the heated pieces of converted iron in a cold fluid. *See* STEEL.

(*x*) CASSIA. The fruit called *Caſſia Fiſtularis* contains a ſweet ſaline ſubſtance, ſoluble in water or in ſpirit of wine. *Neuman*.

(*y*) CASTOR. Two drams and a ſcruple of extract may be obtained from an ounce of caſtor by ſpirit of wine, or by water. By diſtillation with water, the peculiar ſmell of the caſtor is given to the water: hence we may probably infer that it contains an eſſential oil. By diſtillation with ſpirit of wine, none of this peculiar ſmell is given to the ſpirit. *Neuman*.

pieces, while it is ſtill hot and moiſt, and is to be ſpeedily put into a glaſs bottle, well cloſed with a glaſs ſtopper.

An alkali thus treated is much more cauſtic than ordinary fixed alkali. It is alſo more fuſible by fire; and it attracts the moiſture of the air much more readily; for which reaſon it ought to be cut and put into bottles, while it is yet hot, otherwiſe it would become very ſoon moiſt.

This alkali when applied to the ſkin during half or three quarters of an hour, corrodes it, and forms a painful eſchar, like that produced by burning. It is employed to open iſſues, which formerly were much uſed, but were afterwards almoſt aboliſhed. They have ſince been brought again into frequent uſe, and juſtly; for they are serviceable by evacuating vicious fluids which reſiſt other remedies. But at preſent common cauſtic is not much uſed for the opening of iſſues, becauſe it occaſions a quick and long pain. The common method at preſent is to make an inciſion with a knife, and to promote the ſuppuration by methods well known in ſurgery.

The cauſticity of common cauſtic muſt not be believed to proceed from a perfect drying and concentration of the alkali. This concentration does indeed augment its cauſticity; but we are no leſs certain, that independantly of that, alkalis treated with quick-lime are much more active and cauſtic, even when they are fluid, than any other alkalis. This is evident from the effects of the lixivium, or ley of ſoap-boilers, which almoſt inſtantaneouſly corrodes and deſtroys all animal matters. This cauſticity then is cauſed by ſome particular change produced upon alkalis fixed or volatile by quick-lime; which change probably conſiſts in depriving them of ſome unctuous matter, which invelops and blunts their ſaline principle. *See* ALKALI (FIXED), ALKALI (VOLATILE), AMMONIAC SALT, SPIRIT (VOLATILE) *of* SAL AMMONIAC, LIXIVIUM *of* SOAP-BOILERS.

CAUSTIC (LUNAR). Lunar cauſtic, or *Lapis Infernalis*, is a cauſtic made by taking from lunar cryſtals all their water of cryſtallization by fuſion.

To make the lunar cauſtic, cryſtals of ſilver are to be put into a Heſſian crucible, which ought to be large in proportion to the quantity to be uſed, becauſe a conſiderable ſwelling and frothing happens in the beginning of this fuſion. The crucible is to be placed in a furnace which ought to draw little air, and ſurrounded by a very ſmall quantity of lighted coals, becauſe theſe cryſtals are very fuſible, and too great heat would be prejudicial to the preparation of the lunar cauſtic. This matter is then to be very quickly liquefied. In the beginning particularly, the heat ought to be moderate, otherwiſe a part of the matter might flow over the crucible, and deflagrate like nitre upon the coals, by which the ſilver would be reduced. While the ebullition gradually diminiſhes, the fire is to be encreaſed; and when the matter is brought to a perfect and tranquil fuſion, it is to be caſt into an iron mould previouſly heated and greaſed in its inner ſurface. The lunar cauſtic is there to be left till it is fixed and cold, and then it is to be put into a bottle with a glaſs ſtopper. The lunar cauſtic ought to be formed into ſmall cylindrical pieces, like pencils, of about a line in diameter, and the ſurgeon who uſes them puts them in a crayon or pencil caſe, to prevent his fingers being injured by touching them. The mould for the lunar cauſtic is ſo made as to give them that form. It conſiſts of five or ſix hollow cylinders, placed vertically and parallel to each other, to which a gutter is adapted, by means of which the matter is poured into them. This mould is compoſed of two pieces which exactly fit each other, in each of which the ſame number of hollow ſemi-cylinders correſpond to thoſe of the other. By this diſpoſition, when the lunar cauſtic is caſt and cooled, it is obtained in entire cylinders, by ſeparating the two pieces of the mould.

The lunar cauſtic muſt be poured as ſoon as it is in tranquil fuſion, for that degree of heat is ſufficient to carry off its acid, which may be obſerved to diſſipate in fumes; and conſequently, if it was left in the fire long after it is thus fuſed, it would loſe ſome of its cauſticity, which it entirely owes to this acid.

The operation for lunar cauſtic ſhews two remarkable phenomena. The firſt is the black color aſſumed by the cryſtals of ſilver thus fuſed. I believe this color proceeds from a part of the phlogiſton of the nitrous acid, which attaches itſelf to the ſilver ſuperficially, and which always gives a black color to this and other white metals, ſuch as mercury, lead, and biſmuth, when it is thus united to them.

The other remarkable phenomenon is a certain ſymmetry of arrangement, or cryſtallization, which lunar cauſtic takes when it cools and becomes ſolid. If a pencil of lunar cauſtic be broken into pieces, its inner ſubſtance may be obſerved to be compoſed of needles or radii paſſing from the circumference to the center, much like the inſide of the round ferruginous ſulphureous pyrites. This phenomenon is common to all bodies of a certain degree of ſimplicity of compoſition, which paſs without agitation from a liquid to a ſolid ſtate, and is a ſpecies of cryſtallization. Perhaps the ſame phenomenon occurs in many other neutral ſalts in which it has not yet been remarked. *See* CRYSTALLIZATION.

Lunar cauſtic ought to be made with teſted ſilver. If ſilver allayed with copper be uſed, the cryſtals of ſilver ought to be well drained upon brown paper, by which they will be freed from the ſolution of copper, and will become white. This ſolution of copper in nitrous acid when dried is alſo cauſtic, but leſs ſo than lunar cauſtic. It alſo has the inconvenience of becoming moiſt in the air. *See* SILVER, CAUSTICITY, *and* CRYSTALS *of* SILVER.

CAUSTICITY. By this word is denoted a quality belonging to ſeveral ſubſtances, by the acrimony of which the parts of living animals may be corroded, and deſtroyed. Bodies which have this quality, when taken internally are true poiſons. The cauſticity of ſome of theſe, as of *arſenic*, is ſo deadly, that even their external uſe is proſcribed by prudent phyſicians.

Several others, as *nitrous acid*, *lapis infernalis*, or *lunar cauſtic*, *common cauſtic*, *butter of antimony*, are daily and ſucceſsfully uſed to conſume excreſcences, to deſtroy fungous fleſh, to open iſſues, &c. They ſucceed very well when properly employed, and ſkilfully managed.

The cauſticity of bodies depends entirely on the ſtate of the ſaline, and chiefly of the acid matters which they contain. When theſe acids happen to be at the ſame time much concentrated, and ſlightly attached to the matters with which they are combined, they are then capable of acting, and are corroſive and cauſtic. Thus fixed and volatile alkalis, although they are themſelves cauſtic, become much more ſo by being treated with quick-lime, becauſe this ſubſtance deprives them of much fat or inflammable matter, which binds and reſtrains the action of their ſaline principle. (z) By this treatment then, the ſaline principle is more diſengaged, and rendered more capable of action. Alſo, all combinations of metallic matters with acids, form ſalts more or leſs corroſive, becauſe theſe acids are deprived of all their ſuperabundant water, and are beſides but imperfectly ſaturated by the metallic matters.

(z) The ſubſtance which quick-lime takes from alkaline ſalts, by which the diſſolving power of theſe ſalts is encreaſed, is fixable air *See* GAS.

Nevertheleſs, ſome other circumſtance is neceſſary to conſtitute the cauſticity of theſe ſaline metallic matters. For the ſame quantity of marine acid, which when pure and diluted with a certain quantity of water ſhould be incapable of producing any harm, ſhall however produce all the effects of a corroſive poiſon when it is united with mercury in *corroſive ſublimate*, although this ſublimate ſhall be diſſolved in ſo much water, that its cauſticity cannot be attributed to the concentration of its acid.

This effect is attributed by ſome chemiſts to the great weight of the metallic parts with which the acid is united. This opinion is very probable, ſince the cauſticity is nothing but its diſſolving power, or its diſpoſition to combine with other bodies; and this diſpoſition is nothing elſe than attraction, which is one and the ſame thing as weight or gravitation.

CAWK. *(a)*

CEMENT. All thoſe powders and paſtes are called *cements*, with which any body is ſurrounded in pots or crucibles, and which are capable, by help of fire, of producing changes upon that body. Hence the expreſſions *to cement*, and *cementation.*

The principal cements are the *royal cement*, which is uſed to ſeparate ſilver from gold in the operation called *Concentrated Parting*; (*ſee* PARTING (CONCENTRATED) the cement for converting iron into ſteel (*ſee* STEEL); the cement for converting certain glaſs into porcelain (*ſee* GLASS *and* PORCELAIN); the cement for converting copper into braſs. *See* BRASS.

Cements may be made of many various kinds, and for various purpoſes, by varying the materials of the compoſitions. Cementation is generally a very powerful method of producing changes upon bodies, or of forming combinations which could not otherwiſe be eaſily effected; becauſe in this operation the active matters of the cement are in a

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(a) CAWK is a white, very denſe, ſparry ſubſtance, ſoluble in acids, and fuſible by fire. It is generally found in or near lead mines. If an ounce or two ounces of cawk be thrown red-hot upon ſixteen ounces of melted antimony, and the fuſion continued about two minutes; a regulus weighing fifteen ounces will be obtained hard and white. *See Phil. Tranſ. Num.* 110. This experiment Dr. Lewis has frequently repeated with ſucceſs.

ſtate of dryneſs, are reduced into vapors, and aſſiſted by conſiderable heat.

CEMENT-COPPER. (*b*)

CENTAURY. (*c*)

CERUSS, or WHITE LEAD. Ceruſs is a kind of ruſt of lead which has been corroded and half-diſſolved by vapors of vinegar. To make ceruſs, leaden plates rolled ſpirally, ſo that the ſpace of an inch ſhall be left betwixt each circumvolution, muſt be placed vertically in earthen pots of a proper ſize, containing ſome good vinegar. Theſe leaden rolls ought to be ſo ſupported in the pots, that they do not touch the vinegar, but that the vapor of this acid may circulate freely betwixt the circumvolutions: theſe pots are to be covered, and placed in a bed of dung, or in a ſand-bath, by which a gentle heat may be applied. The acid of vinegar, which very well diſſolves lead, being thus reduced into vapors, eaſily attaches itſelf to the ſurface of theſe plates, penetrates them, and is impregnated with this metal, which it reduces to a beautiful white powder called *Ceruſs:* when a ſufficient quantity of it is collected on the ſurface of the plates, the rolls are taken out of the pots, and unfolded; the ceruſs is then taken off, and they are again rolled up, that the operation may be repeated.

This management is very ingenious; becauſe the plates of lead thus diſpoſed preſent the greateſt ſurface to the vapors of vinegar, while they occupy the leaſt poſſible ſpace.

As in this operation the acid of vinegar is overcharged with lead, this metal thus changed into ceruſs, is not properly in a ſaline ſtate; hence ceruſs is not in cryſtals, nor is ſoluble in water: but a ſaline quality would render it unfit for painting, for which it is chiefly employed.

Ceruſs ground and prepared for painting is called *white lead.* It is the only white hitherto found fit for painting in oil. The diſcovery of another white for this purpoſe is deſirable, not only from its faults as a paint, but alſo from

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(*b*) CEMENT, *or* ZIMENT COPPER, is copper precipitated from vitriolic waters by iron. The name is derived, as is ſaid, from a vitriolic water in Hungary called ziment.

(*c*) CENTAURY. The leaves of the leſſer centaury contain a bitter ſubſtance ſoluble by water, or by ſpirit of wine. The green color of the plant reſides in the reſinous part, being extracted by ſpirit of wine, but not by water.

its injuring the health of perſons employed in its manufacture, by affecting them with a ſevere diſeaſe, which lead and all its preparations frequently occaſion, called the *colic of minerals*, or the *colic of painters*.

Ceruſs, like the other preparations of lead, is drying, ſedative, and lenient; as ſuch it is employed, but only externally. It is an ingredient in many ointments, plaiſters, and other pharmaceutical preparations deſigned for external maladies.

As lead is much divided in ceruſs, and is already penetrated with a certain quantity of acid of vinegar, its ſaturation with this acid may be eaſily compleated, by diſſolvin gceruſs in diſtilled vinegar. Thus the lead is entirely reduced to a ſaline ſtate. From this ſaturation a cryſtallizable neutral ſalt with metallic baſis reſults, called *ſugar* or *ſalt of lead*. *See* SUGAR *of* LEAD.

CERUSS *of* ANTIMONY. This name is given by ſome chemiſts to a pearl-colored matter, or white earth, which ſeparates from the water with which diaphoretic antimony has been waſhed. It is the fineſt part of the white calx of antimony, which has been diſſolved by the alkali of nitre formed in this operation. The peculiar earth of the alkali, ſome of which always ſeparates after every calcination and ſolution, probably makes a part alſo of the ceruſs of antimony. *See* DIAPHORETIC MINERAL.

CHALK. Chalk is a calcareous earth, found in form of friable ſtones, and therefore cannot be poliſhed as marble and other hard calcareous ſtones may. Chalk is alſo found in powder. This ſubſtance has all the properties which characterize calcareous earths. *See* EARTHS (CALCAREOUS).

CHALK (BLACK). *(d)*

CHARACTERS. Chemical characters are ſigns invented to repreſent the principal ſubſtances and operations in a conciſe manner. Theſe ſigns ought to be underſtood, becauſe they are uſed by many authors, and in tables of affinities. *See the annexed* TABLE *of* CHEMICAL CHARACTERS.

(d) CHALK (BLACK); *humus nigra pictoria*; *atramentum ſciſſile*. This is a light, earthy, flakey ſubſtance uſed for drawing black lines on paper, and for mixing with oil or water for the uſe of painters. It is calcinable by fire to a reddiſh white earth. It is unſoluble by acids, and ſeems to be a bituminous ſlate. Wallerius ſays, that in Sweden, near Huneberg, a black earth is found as diffuſible in water as Indian ink.

CHEESE. Cheeſe is the mucilaginous or gelatinous part of milk. As the milk of all animals is a true emulſion, the cheeſe or caſeous part of milk is an intermediate ſubſtance by which the oily or butyraceous part of this liquor is divided, and ſuſpended in the ſerous part. Thus cheeſe is in milk what mucilage is in emulſions or milky juices of vegetables; but although it has ſome properties common with mucilages, it differs in other reſpects, particularly in its want of ductility, or its viſcidity, and in its property of coagulating by heat and by acids.

Milk is compoſed of three very different ſubſtances, butter, cheeſe, and whey. Theſe ſubſtances are only well mixed together, but not combined, ſince they are capable of a ſpontaneous ſeparation or analyſis: but this ſeparation is not entire and exact, except it be procured by methods peculiar to each of theſe ſubſtances. *See* BUTTER, MILK, *and* WHEY.

To have cheeſe as pure as is poſſible, freſh milk, after the cream is well taken off, muſt be curdled by runnet, or by cream of tartar; the whey then muſt be well drained from it, and it muſt be frequently waſhed with much pure water.

If it be then expoſed to diſtillation with a graduated heat, at firſt a phlegm ariſes which has a ſlight ſmell of milk or of cheeſe, without any marks of an acid or of an alkaline quality. This phlegm ariſes with the heat of boiling water; and when the heat is encreaſed an oily and ſaline ſpirit ariſes. The ſaline part of this ſpirit is generally a volatile alkali. Afterwards a ſmall quantity of empyreumatic oil ariſes, which is at firſt fluid, and becomes more and more thick and fetid. Concrete volatile alkali alſo ariſes in this diſtillation; and at length when the retort is very red-hot, and nothing more riſes, a conſiderable quantity of coal remains. This coal is of that kind which cannot be burnt without very great difficulty.

From this analyſis of cheeſe, which reſembles the analyſis of all animal matters, this ſubſtance appears to be the moſt animaliſed part of the milk; for butter and whey furniſh other principles, and particularly much acid. We muſt, however, obſerve, that cheeſe made of the milk of frugivorous animals may furniſh acid, inſtead of volatile alkali. This difference depends perhaps on the nature of the aliments uſed by the animals from which the milk is taken, and alſo of their temperaments, diſpoſitions, and nature of their digeſtions; for, in general, the ſtate of the acid, and its greater or leſs diſpoſition to be transformed into volatile alkali, are very variable in the animal kingdom, particularly in thoſe animals which live only on vegetables, and in their milk, which ſtill more approaches to a vegetable nature.

This matter, although very intereſting, has been much neglected by chemiſts. We find, in the Elements of Practical Chemiſtry, an analyſis of cheeſe produced from cows milk, and in that analyſis no mention is made but of an acid, which ſhews the variations that may happen in this matter. We wiſh it were examined as accurately as it deſerves; but for this purpoſe many experiments which require much time and favourable circumſtances ought to be made; which could not be done without having ſeveral cows of different ages, fed with different herbs and grains, at different periods from their having calved, and at different ſeaſons of the year. *See* MILK.

CHEMISTRY. Chemiſtry is a ſcience, the object of which is to diſcover the properties of bodies by analyſis and by combination.

The advantages reſulting from this ſcience are too manifeſt and too numerous to require an enumeration in ſuch a work as this.

CHERT. *(e)*

CHRYSOLITE. *(f)*

CINNABAR. Cinnabar is of two kinds; one is native, the other is artificial.

(e) CHERT, *or* CHERTZ; *petroſilex ſemipellucidus, lapis corneus, hornſtein of the Germans.* Chert is a ſemi-tranſparent ſtone of the ſiliceous kind. *See* its chemical properties under the article EARTH (VITRIFIABLE). It is generally leſs hard and of a coarſer texture, than common flints. Large quantities of chert are found in beds of lime-ſtone, as flints are found in the beds of chalk, with this difference, that flints conſiſt of looſe nodules, and chert often forms large maſſes of the rock. They are uſed as grinding ſtones for grinding calcined flints, and other hard ſubſtances, but have too ſmooth and cloſe a texture for the grinding of corn.

(f) CHRYSOLITE is a pellucid, yellowiſh green ſtone or gem, the ſixth in hardneſs from diamonds, yet ſuſceptible of impreſſion from a file. By fire it ſuffers no other change than loſs of color. It is probably a ſpecies or variety of topaz. Its chemical properties *ſee* under the article EARTH (VITRIFIABLE). This gem may be imitated by adding twenty grains of crocus martis to two ounces of cryſtal-glaſs, and ſix ounces of minium.

Native cinnabar is a heavy and brittle mineral, of a very deep red color when it is in a lump, and conſiſts of ſhining, needle-like, parallel ſtriæ.

This mineral is compoſed of mercury and ſulphur, as will be proved when we ſhall relate its analyſis. It is, properly ſpeaking, mercury mineraliſed by ſulphur, or a true ore of mercury.

Cinnabar cannot be attacked in the humid way by any chemical agent. It is volatile; ſo that, when expoſed to fire in cloſe veſſels, it is entirely ſublimed, without ſuffering any decompoſition. The ſublimation may be repeated any number of times without any change upon the ſubſtance.

If cinnabar be expoſed to the action of fire, with acceſs of air, it is decompoſed by the burning of its ſulphur, and then the mercury diſengages itſelf in vapors; but as theſe vapors are not eaſily to be collected, and as many of them would be loſt by this method of decompoſition with acceſs of air, another method is employed of decompoſing cinnabar in cloſe veſſels, by means of ſome ſubſtance to which ſulphur has a greater affinity than to mercury. Many ſubſtances are known to be poſſeſſed of the quality required for this purpoſe.

Fixed alkalis, quicklime, calcareous earths, iron, copper, tin, lead, ſilver, biſmuth, and regulus of antimony, have a greater affinity than mercury has to ſulphur, and conſequently are capable of decompoſing cinnabar. Of theſe ſubſtances iron is found to be the moſt convenient, and is therefore moſt uſed for the decompoſition of ſmall quantities of cinnabar. When this decompoſition is to be made, equal parts of filings of iron and cinnabar are to be well mixed together, and put into a retort, which is to be expoſed in a furnace to a naked fire, or in a ſand-bath ſo diſpoſed that a ſufficiently ſtrong heat may be applied; a receiver containing water is to be adapted to the retort, and the diſtillation to be promoted. The mercury diſengaged from the ſulphur by means of iron is raiſed into vapors, moſt of which are condenſed in the receiver, at the bottom of which, under the water, they appear changed into fluid mercury; a ſmall part of the mercury remains much divided, and floats on the ſurface of the water in form of a black powder, which muſt be carefully collected, and mixed with the maſs of fluid mercury, with which it eaſily incorporates; this mercury, which is then to be ſtrained through cloſely woven linen, is very pure. It is called *mercury revivified from cinnabar*; and this reduction is called *revivification of mercury from cinnabar.* In the retort is found a maſs compoſed of the iron employed, and of the ſulphur of the cinnabar; or if, inſtead of iron, ſome other ſubſtance was employed, it would be found after the operation united with the ſulphur. Thus if an alkali or calcareous earth has been employed, an earthy or alkaline liver of ſulphur will be found. *See* SULPHUR.

By weighing the cinnabar employed in this proceſs, and the mercury obtained by it, this mercury is found to be ſeven-eighths of the whole cinnabar. Thus in cinnabar ſeven parts of mercury are united with one part of ſulphur.

From a knowledge of the conſtituent parts of cinnabar we may learn a method of compoſing an artificial cinnabar entirely ſimilar to the natural. For this purpoſe, mercury and ſulphur muſt be fuſed and triturated together till they unite well, and form a black body called *Ethiops mineral. See* ETHIOPS MINERAL. This Ethiops mineral is then to be ſublimed; but we muſt obſerve, that the operation is attended with ſome difficulties; ſo that a beautiful and perfect cinnabar, in which the mercury and ſulphur are exactly proportioned, cannot be obtained by the firſt ſublimation. The firſt ſublimate is always overcharged with ſulphur, which gives it a black color. The reaſon of this is, that more ſulphur is neceſſarily employed to make the ethiops mineral than is ſufficient to form cinnabar: but by each ſubſequent ſublimation ſome of that ſuperfluous ſulphur is ſeparated, till at length, by five or ſix ſublimations, it becomes entirely ſimilar to native cinnabar. (g)

CINNABAR *of* ANTIMONY. An artificial cinnabar may alſo be obtained from the decompoſition of corroſive ſublimate by antimony. This operation is performed by mixing together and diſtilling theſe two compound ſubſtances. The marine acid of corroſive ſublimate, which has a ſtronger affinity to regulus of antimony than to mercury, quits this latter ſubſtance to combine with the former, with which it forms a new compound called *butter of antimony*, that paſſes by diſtillation into the receiver. *See* BUTTER *of* ANTIMONY.

(g) Hoffman ſays, that cinnabar may be produced without ſublimation, by ſhaking or digeſting a little mercury with volatile tincture of ſulphur, by which means the mercury imbibes the ſulphur from the volatile ſpirit, and forms with it a deep red powder, the color of which is not inferior to that of ordinary cinnabar.

Alſo the mercury of the corroſive ſublimate, being diſengaged from its marine acid, unites with the ſulphur of the antimony likewiſe diſengaged from its regulus; and theſe two ſubſtances, thus united, are ſublimed in form of cinnabar after the butter of antimony has been diſtilled: but although in this proceſs the mercury is not previouſly united with the ſulphur into an ethiops, the ſame ſuperfluity of ſulphur is perceived in the cinnabar produced by this as by the former operation; becauſe the quantity of antimony neceſſarily employed for the compleat decompoſition of coroſive ſublimate, contains more than the requiſite quantity of ſulphur for the formation of perfect cinnabar with the quantity of mercury contained in the corroſive ſublimate. This inconvenience is to be remedied by the method directed in the former proceſs; that is, by repeating the ſublimation till the cinnabar becomes perfect, and entirely ſimilar to the native. It is called *cinnabar of antimony*, becauſe its ſulphur has been furniſhed by antimony.

The chief uſe of cinnabar is for painting. Although this body be compoſed of ſulphur, the color of which is a light citron, and of mercury which is white as ſilver, it is nevertheleſs of an exceeding ſtrong red color. Lumps of it are of a deep brown red, without brilliancy. But when the too great intenſity of its color is diminiſhed by bruiſing it and dividing it into ſmall parts, (which is a method generally uſed to leſſen the intenſity of all colors) the red of the cinnabar becomes more and more exalted, flame-colored, and exceedingly vivid and brilliant. In this ſtate cinnabar is called *vermilion*.

Cinnabar is often employed as an internal medicine. Hoffman greatly recommends it as a ſedative and antiſpaſmodic; and Stahl makes it an ingredient in his *temperant powder*. Other very intelligent phyſicians, and particularly Mr. Cartheuſer, deny that cinnabar taken internally has any medicinal quality. Their opinion is grounded on the unſolubility of cinnabar by any menſtruum. This queſtion concering the utility of cinnabar taken internally cannot be decided without new reſearches and experiments. But cinnabar is certainly uſed ſucceſsfully to procure a mercurial fumigation, when that method of cure is proper in venereal diſeaſes. For this purpoſe cinnabar is burnt in an open fire on red-hot coals, by which the mercury is diſengaged, and forms vapors, which being applied to the body of the diſeaſed perſon, penetrate through the pores of the ſkin, and produce effects ſimilar to thoſe of mercury adminiſtered by friction.

When fumigations of cinnabar are applied, the patient ought not to be expoſed to breathe the vapors of the mercury and of the burning ſulphur, which might injure him. *See* MERCURY *and* SULPHUR. *(h)*

CINNAMON. *(i)*

CIVET. *(k)*

CLAY, *or* ARGILLACEOUS EARTH, is a particular kind of ſtrong earth, conſiderable banks of which are found almoſt every where, at greater or leſs depths. The general properties and characteriſtics of pure clay are:

1. This earth makes no ſenſible efferveſcence with acids, although it be capable of ſolution by acids, as we ſhall ſee.

2. Clay being moiſtened with water, imbibes ſome of that liquid, ſwells, and mixes with it.

3. When it is mixed with no more than the neceſſary quantity of water to reduce it to a moderately ſoft paſte, it is ſo ductile as to be capable of being worked upon a potter's wheel, and of being formed in moulds. By theſe means veſſels may be made of it which keep their form.

4. Clay is denſe, compact, and cloſe. When its ſurface is rubbed with a poliſhed body, it alſo becomes poliſhed.

5. If it be expoſed when moiſt to a gentle heat, it gradually dries and contracts; that is, its dimenſions become leſs; hence it is very apt to crack. *(l)* It retains moiſture pretty ſtrongly, and difficultly allows the laſt portions of it to eſcape.

(h) Some native cinnabars, according to Bruckman, *(Epiſtol. Itiner.)* are ſo hard, that they are poliſhed, turned in a lathe, and wrought like marble.

(i) CINNAMON. From 16 oz. of the beſt cinnamon ſcarcely more than two ſcruples and a half of eſſential oil can be obtained. This oil may be raiſed by diſtillation with water, but ſcarcely with ſpirit of wine. The whole taſte and flavor of cinnamon may be extracted by digeſtion with ſpirit of wine. *Neuman.*

(k) CIVET is an odoriferous unctuous animal juice, ſoluble in oils, but not in ſpirit of wine, nor in water, even by means of ſugar. *Neuman.*

(l) Dr. Lewis found from experiments, that pure clay ſoftened with water to a due conſiſtence to be worked upon a potter's wheel, contracted by drying $\frac{1}{12}$th part of every dimenſion.

6. If clay be heated much, and quickly, before it be perfectly dried, it burſts with loud noiſe from the effort made by the water rarefied and changed into vapor, to eſcape from the parts of this tenacious earth which invelop it. Thus this burſting and cracking do not happen, if the clay expoſed to heat contain water enough to render it ſoft; becauſe then the water finding much leſs reſiſtance from the clay, only ſeparates the argillaceous parts from each other, and eſcapes with conſiderable intumeſcence.

7. If pure clay, previouſly well dried, be expoſed to a very violent fire, ſuch for example, as the fire of a glaſs-houſe, it does not melt, and reſiſts much more than ſand does the action of fluxes and vitrifying matters. By fire its parts are only very ſtrongly agglutinated; and the maſs of clay thus calcined is called *baked clay*. During this baking it contracts in every dimenſion, and becomes as hard as flint, ſo that it is capable of ſtriking fire with ſteel.

8. When clay has been thus baked by fire, it becomes no longer penetrable by water. If it be ground and levigated, it mixes with water as very fine ſand does; that is, it does not form, as the crude clay does, a tenacious, ductile paſte, fit to be turned on a potter's wheel.

9. Clay is entirely ſoluble in acids, and particularly in the vitriolic, with which acid it forms a vitriolic ſalt with an earthy baſis, which is true alum. *See* ALUM.

10. Laſtly, clay, which, when unmixed, perfectly reſiſts the moſt violent fire without ſhewing any tendency to fuſion, being mixed with equal parts of any calcareous or gypſeous earth, and with two parts and a half, or three parts of any ſand or vitrifiable ſtone, now becomes fuſible, and diſpoſes the other two earths to fuſion.

All the properties which we have enumerated are eſſential to argillaceous earth, when perfectly pure; that is, when free from any mixture of heterogeneous matter. Clay ſo perfectly pure has never yet been found in the earth.

Mr. Macquer, in his Memoir upon clays given to the Academy in the year 1762, from which Memoir the greateſt part of the preſent article is taken, obſerves, that clay being an earth miſcible with water, is liable to mixture with many other matters, and that from this cauſe we never find pure clay, which ought eminently and excluſively to poſſeſs the argillaceous properties, and which ought to be always the ſame, without any peculiar differences; and laſtly, that the only certain method of procuring this earth is to extract it from native clays, or from other bodies which contain it, by means of vitriolic acid, with which it forms alum; and then to decompoſe this alum by phlogiſton or alkalis, which diſengage the vitriolic acid; therefore, properly ſpeaking, earth of alum well prepared can be conſidered as the only pure clay. Further, this earth has ſo ſtrong affinity with phlogiſton, that we cannot expect to obtain it perfectly free from this principle. The general properties of clay, deſcribed above, are therefore ſolely applicable to this kind of earth. *See the word* ALUM.

Native clays poſſeſs more or leſs of theſe properties in proportion as they are leſs or more altered by mixture of heterogeneous matters.

As clays are very uſeful in chemiſtry, in arts, and in many purpoſes of ordinary life, we ſhall mention ſome important parts of knowledge concerning them; as, the methods of diſcovering their purity, the places where they may be found, and the means of purifying them.

The purity of clays is known by the general properties above related. The more any native clay poſſeſſes of theſe properties, the purer it is.

The ſubſtances which hurt the purity of native clays are ſand, phlogiſton, bituminous matters, vitriolic acid, metallic earths, pyritous matters, calcareous earths, and mica.

Inflammable matters alter the color of clay, which when pure ought to be white. Its color is affected alſo by colored metallic earths, particularly by thoſe of copper and iron, and by all pyritous matters.

Clay, which is colored only by an inflammable matter which is not metallic, loſes its color by fire with acceſs of air, and becomes white. Of this kind are moſt grey and brown clays, of an uniform color, and not veined.

Clays colored by pyritous matters, or by earths of iron or copper, are not rendered white by fire, till they are perfectly deprived of theſe metallic earths. A certain quantity of theſe heterogeneous ſubſtances in clay render it fuſible. Such clays are known by their colors, which are yellow, red, green, or veined, and marbled with ſeveral of theſe colors. They are the moſt unfit of all clays for the making of utenſils intended to ſuſtain intenſe heat, ſuch as chemical veſſels, and the bricks, crucibles, or pots uſed in glaſs-houſes.

We may obſerve, that even the pureſt native clays are never entirely free from a mixture of ſome parts of metallic, particularly ferruginous earth. Mr. Macquer, who has examined above eight hundred clays, ſays, in the above quoted Memoir, that in all that number he did not find one, even amongſt the whiteſt, that was entirely pure and free from metallic matter: but when a very ſmall quantity only of ferruginous earth is in clays; when it is not uniformly mixed with them through all their maſs, which is known by a beautiful and pure white color, but is diſperſed in ſmall yellow ſpots, as it frequently is; then ſuch clays ought to be conſidered as being of a very good quality. The only practical method of ſeparating theſe ferruginous parts, is to break the clay into ſmall lumps, and to cut out the yellow ſpots. This ought to be done before the clay is mixed with water; becauſe, by waſhing, the ferruginous parts are not ſeparable, but are more intimately mixed with the purer part of the clay.

Pyritous matters, mica, and coarſe ſand mixed with clays render them brittle, and diminiſh their ductility. Clays are eaſily cleanſed from the greateſt part of theſe heterogeneous ſubſtances by waſhing; that is, by mixing the clay well with much pure water, which is left to reſt till only the fineſt and lighteſt parts of the clay remain ſuſpended in the water, the groſſer parts having ſubſided to the bottom: the water then is to be decanted off from the groſs ſediment, and paſſed through a fine ſilken ſearce: the ſediment which is depoſited from this decanted and ſifted water is the fineſt and pureſt part of the clay, and ought to be carefully and cleanly collected and dried. This purification of clay by waſhing is very neceſſary when good pottery or porcelain is to be made. *See* POTTERY *and* PORCELAIN.

The pyritous particles found in clays render them very fuſible. A bit of pyrites left in clay which is expoſed to a baking fire, always forms a cavity in the clay lined with a black leaden color.

The waſhing with water is an effectual method of ſeparating from clay even the ſmalleſt particles of pyrites; becauſe theſe particles have eſſentially a ſpecific gravity much greater than that of clay. But ſand and mica are not ſo eaſily ſeparated from clay. Mr. Macquer has ſhewn in his Memoir, that the moſt careful waſhing is inſufficient for an entire ſeparation of ſandy particles contained in clays; becauſe every native clay contains a conſiderable quantity of ſandy particles as fine and as light as the clay itſelf.

Mica alſo cannot be ſeparated from clay for the ſame reaſon: but theſe fine partrcles of ſand and mica, which cannot be ſeparated by waſhing, do not injure works made of clay, but are rather uſeful by preventing cracks in drying and baking. *See* POTTERY.

The particles of calcareous earths which injure the purity of many native clays, are eaſily diſcovered by the effervеſcence which they make with nitrous acid. This kind of earth cannot be ſeparated from clays by waſhing, from the fineneſs and lightneſs of its parts. Clay containing a certain quantity of calcareous earth is by this mixture rendered fuſible, from the ſandy particles inſeparable from the clay: hence all calcareous clays are improper for making utenſils intended to ſuſtain intenſe heat.

Laſtly, vitriolic acid, which appears to have been combined and diſtributed in a ſingular manner by nature in all clays, may be ſeparated from them by digeſting them in an alkaline liquor, and afterwards by edulcorating this clay with a ſufficient quantity of water: but this purification of clays is not neceſſary for moſt purpoſes to which theſe earths may be applied; becauſe this acid is not injurious. Vitriolic acid mixed with clays renders them capable of decompoſing nitre and common ſalt, and of diſengaging the acids of thoſe ſalts.

Theſe extraneous matters being found naturally mixed with clays either ſingle, or ſeveral together, and in all proportions, occaſion a great variety of native clays. No earth has ſo many different kinds; and undoubtedly from this great variety proceeds the multiplicity of names which are annexed to the ſeveral kinds of clay.

The earths called *boles*, *bolar earths*, and *ſealed earths*, are true clays. Theſe names have been chiefly applied to thoſe clays which ſtick ſtrongly to the tongue, and alſo to certain clays filled with a large quantity of ferruginous earth, by which they are uniformly colored red or yellow. Other names are applied to clays from their particular uſes. Such are *fuller's-earth*, *tile-earth*, *brick-earth*, *potter's-clay*, *pipe-clay*, *porcelain-clay*.

The earths called *marles*, as they are capable of dilution in water, have a certain degree of binding quality, effervеſce with nitrous acid, are fuſible with an intenſe heat, and appear to be nothing elſe than clays more or leſs ſandy, and mixed with much calcareous earth.

Laſtly, epithets are given to many clays denoting their color, as *white clays*, *grey clays*, *blue clays*, *&c.*

But theſe names communicate little knowledge on the true nature of the ſeveral native clays. A more particular examination by chemical proofs is requiſite to inveſtigate the heterogeneous matters with which different native clays are mixed, the mixture of which alters the purity of ſimple and primary argillaceous earth, to which they owe all they poſſeſs of argillaceous properties; then names might be given which ſhould indicate their color and the heterogeneous matters with which they are mixed, or at leaſt thoſe which prevail moſt. Thus amongſt theſe names we ſhould have *white*, *ſandy*, *micaceous*, or *calcareous clays*; *grey* or *blue pyritous clays*; *red* or *yellow ferruginous clays*; *black bituminous clays*, &c.

As our intention in this work is not to enter into the details of natural hiſtory, we ſhall ſay no more upon this ſubject. What we have ſaid concerning the properties of pure clay, and the different ſubſtances which alter its purity, and more or leſs diſguiſe the argillaceous properties of native clays, is ſufficient to give a notion of the light which chemiſtry can throw on natural hiſtory in this and many other inſtances.

In Mr. Gellert's table the ſubſtances capable of acting upon clays are ſet down in the following order: Vitriolic acid, partly (*ſee* an explanation of this word *partly* at the article ALUM), liver of ſulphur, fixed alkali, borax, calx of lead, calx of antimony, gypſeous earth, calcareous earth.

CLOVES. *(m)*

CLYSSUS. By the word *clyſſus* are meant the vapors which riſe during the detonation of nitre with any inflammable body. Theſe vapors may be collected and condenſed into a liquor by a proper apparatus of veſſels.

The vapors reſulting from the detonation of nitre with charcoal are called *clyſſus of nitre*. To prepare this clyſſus,

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(m) CLOVES. The pungency of cloves reſides in their reſin, or rather in a combination of reſin with eſſential oil; for the ſpirituous extract is very pungent; but if the oil and the reſin contained in this extract be ſeparated from each other by diſtillation, the oil will be very mild; and any pungency which it does retain proceeds from ſome ſmall portion of adhering reſin, and the remaining reſin will be inſipid. No plant, or part of any plant, contains ſo large a portion of eſſential oil as cloves do. From ſixteen ounces Neuman obtained by diſtillation two ounces and two drams, and Hoffman obtained from the ſame quantity an ounce and a half. This oil is ſpecifically heavier than water. *Neuman.*

an earthen retort muſt be employed capable of ſuſtaining a great heat applied ſuddenly without injury.

This retort, which ought to be tubulated, is to be placed in a furnace, and to it a very large balloon with a ſmall hole is to be adjuſted. When the bottom of the retort has become red-hot, a ſmall quantity, that is, a dram and a half, or two drams, of a mixture of purified nitre and charcoal powder, is to be thrown into the retort through the tubulated part, which muſt be immediately afterwards cloſed; the nitre then detonates, and the vapors are condenſed in the receiver.

Other parcels of the detonating mixture are to be thrown in ſucceſſively with the ſame management, till a ſufficient quantity of liquor is collected in the receiver. If, inſtead of charcoal powder, ſulphur be employed to detonate with nitre in cloſe veſſels, the liquor obtained is called *clyſſus of ſulphur*; and if antimony be employed to detonate with nitre, the liquor is called *clyſſus of antimony*.

The old chemiſts, who practiſed theſe operations, believed that the liquors thus obtained had particular virtues for alchemical purpoſes. For this reaſon, they made this preparation with great apparatus and trouble. But now, when chemical operations are better underſtood, theſe liquors are believed to have no virtues. The clyſſus of nitre is made in laboratories, not for any uſe to which it can be applied, but to eſtabliſh a theory concerning the nature of nitrous acid, and to prove that this acid is entirely deſtroyed and decompoſed by detonation.

For, when the operation is finiſhed, nothing is found in the retort but the alkali which was the baſis of the nitre; and the liquor contained in the receiver has no acid taſte, does not redden the tincture of turnſol, makes no effervеſcence with alkaline matters, and is truly nothing but water, which is ſometimes ſlightly alkaline, becauſe the force of detonation is capable of raiſing ſome ſmall part of the alkali of the nitre.

The clyſſus of ſulphur is acid, becauſe the vitriolic acid of the ſulphur is not decompoſed, as the nitrous is, by combuſtion, but is diſengaged and ſet at liberty by the burning of the phlogiſton of the ſulphur. Beſides, one part of this vitriolic acid when diſengaged acts upon the nitre, forms with its baſis a vitriolated tartar called *Glaſer's ſal polychreſtum*, and diſengages the nitrous acid. This portion of nitrous acid thus diſengaged by the acid of ſulphur, and which is no longer retained and fixed by an alkali, is not capable of inflaming with phlogiſton: wherefore it is not decompoſed, and, together with the vitriolic acid which is not fixed by the alkali of the nitre, makes part of the clyſſus.

The clyſſus of ſulphur appears then to be compoſed, 1. Of a part of the nitrous acid deſtroyed by inflammation with the phlogiſton of the ſulphur: 2. Of another portion of nitrous acid which is not decompoſed, but is diſengaged by the acid of ſulphur: 3. Of all the acid of ſulphur which does not unite with the alkaline baſis of the nitre.

The clyſſus of ſulphur muſt differ conſiderably according to the proportions of nitre and of ſulphur employed. If a little nitre be added to much ſulphur, the clyſſus will be almoſt all pure acid of ſulphur.

An Engliſh chemiſt *, ſome time ago, found a method of obtaining very advantageouſly the vitriolic acid of ſulphur, by burning ſulphur in cloſe veſſels with a ſmall quantity of nitre. This method of decompoſing ſulphur for the extraction of its acid is ſaid to be executed in great, and to be the cauſe of the great reduction of the price of that acid within theſe few years paſt. This is an inſtance of practical utility from a clyſſus; for the vitriolic acid obtained by detonation of nitre in cloſe veſſels is a true clyſſus of ſulphur.

The clyſſus of antimony is ſimilar to that of ſulphur; for the nitre in this operation chiefly detonates with the ſulphur of the antimony: however, the phlogiſton of the metalline part of the antimony contributes alſo to the detonation. Beſides, ſome flowers of antimony are mixed with this clyſſus.

Several neceſſary precautions ought to be taken to make this operation of a clyſſus ſucceed, and to avoid accidents; for the rapidity and violence with which nitre detonates in certain circumſtances may occaſion a ſtrong exploſion and rupture of the veſſels. To prevent theſe accidents, the inflammable matters ought not to be very well mixed with the nitre, becauſe the detonation is proportionably ſtronger and quicker as the mixture has been made more exactly. Alſo, a ſmall quantity only of the mixture ought to be detonated at once, and another quantity ſhould not be added till the detonation of the former be finiſhed. *See* NITRE, DETONATION *of* NITRE, *and* GUN-POWDER.

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* Dr. Ward. *See* SPIRIT *of* SULPHUR.

COAGULATION. This term is employed by chemiſts to denote certain operations in which fluid bodies become ſolid; for inſtance the cryſtallization of ſalts. *See* CRYSTALLIZATION.

COAGULUM. This Latin word is uſed to ſignify curdled concretions formed by the mixture of two liquors, ſuch as the precipitate of ſilver in the formation of *luna cornea*, the *offa Helmontii*, the *miraculum chemicum*, and many others. *See theſe words.*

COAL. By the word *coal* is meant any ſubſtance containing oil which has been expoſed to fire in cloſe veſſels, ſo that all its volatile principles are expelled, and that it can ſuſtain a red heat without further decompoſition. Coal is a body ſolid, black, very dry, and conſiderably hard.

The ſpecific character of perfect coal is its capacity of burning with acceſs of air, while it becomes red-hot and ſparkles, ſometimes with a ſenſible flame which gives little light, no ſmoke or ſoot capable of blackening white bodies.

Coal is capable of communicating its inflammable principle either to the vitriolic acid, with which it forms ſulphur; or to the nitrous acid contained in nitre, with which it inflames; or to metallic earths, which it reduces into metals. But the phlogiſton cannot paſs from coal to form theſe new combinations without the aſſiſtance of red-heat.

Coal ſeems to be an unalterable compound in every inſtance but theſe mentioned, of burning in open air, and of communicating its phlogiſton to other bodies: for it may be expoſed in cloſe veſſels to the moſt violent and continued fire without ſuffering the leaſt alteration. No diſpoſition to fuſe, nor any diminution of weight can be perceived. It is a ſubſtance exceedingly fixed, and perhaps the moſt refractory which is known.

No change is produced upon coal by air or by water, nor by the moſt powerful menſtruums of chemiſtry, excepting perhaps by particular proceſſes. A trial might be made whether the concentrated mineral acids, or cauſtic alkalis, would not, when aſſiſted by heat, make ſome alteration upon coal in a long time. The younger Mr. Rouelle propoſed as a problem, in the Journal de Medicine for October, 1762, to *diſſolve vegetable coal in the palm of the hand.* Why he propoſed it as a problem we do not know; ſince he adds, that Mr. Wolf has reſolved it, and that this ſolution may be made by liver of ſulphur. He has not explained whether he means the ſolution of all the ſubſtance of the coal, or of its phlogiſton only.

Coal is evidently a reſult of the decompoſition of the compound bodies from which it is obtained. It conſiſts of the greateſt part of the earthy principle of theſe compound bodies, with which a part of the ſaline principles, and ſome of the phlogiſton of the decompoſed oil are fixed and combined very intimately.

Coal can never be formed but by the phlogiſton of a body which has been in an oily ſtate: hence it cannot be formed by ſulphur, phoſphorus, metals, nor by any other ſubſtance the phlogiſton of which is not in an oily ſtate.

Alſo every oily matter treated with fire in cloſe veſſels furniſhes true coal; ſo that whenever a charry reſiduum is left, we may be certain that the ſubſtance employed in the operation contained oil. *See* OIL.

Laſtly, the inflammable principle of coal, although it proceeds from an oil, is certainly not an oil, but is pure phlogiſton; ſince coal added to vitriolic acid can form ſulphur, to phoſphoric acid can form phoſphorus, to metallic earths can form metals, and can detonate with nitre; and ſince oil can produce none of theſe effects, till it has been decompoſed and reduced to the ſtate of coal. *See* SULPHUR, PHOSPHORUS, METALS, NITRE, *and* OIL.

Beſides, the phenomena accompanying the burning of coal are different from thoſe which happen when oily ſubſtances are burnt. The flame of charcoal is not ſo bright as that of oil, and produces no ſmoke or ſoot.

All the phlogiſton of coal is not burnt in open air, particularly when the combuſtion is ſlow. One part of it exhales without decompoſition, and forms a vapor, or an inviſible and inſenſible gas. This vapor, or this phlogiſton, diſengaged from coal, is very pernicious. It ſo affects the brain and nerves as to occaſion inſtant death. For this reaſon, to remain in a cloſe place where charcoal or other coal is burnt, is dangerous. Perſons ſtruck by vapor of charcoal are ſtunned, faint, ſuffer a violent headach, and fall down ſenſeleſs and motionleſs. If they are yet alive, the beſt method of recovering them is to expoſe them as quickly as is poſſible to open air, and to make them ſwallow vinegar, and breathe its ſteam. Acids, and particularly vinegar, ſeem to have a property of fixing and reſtraining in ſome ſort the action of phlogiſton, and of the vapors of volatile inflammable matters, which produce ſimilar effects on animals. For this reaſon, vinegar diminiſhes the accidents of intoxication occaſioned by ſpirituous liquors and by opium. The vapor which exhales from liver of ſulphur, particularly when a large quantity of it is decompoſed by an acid, and the vapors which exhale from matters undergoing the ſpirituous or putrid fermentation produce the ſame accidents as the vapors of coal, and are remedied by the ſame means.

Amongſt coals, ſome differences are obſervable, which proceed from the difference of the bodies from which they are made; particularly, ſome coals are more combuſtible than others. This combuſtibility of coals ſeems to depend on the greater or leſs quantity of ſaline principle contained in coal; that is to ſay, that the more it contains of ſaline principle, the more eaſily it decompoſes and burns. For example, coals made of plants and wood, containing much ſaline matter capable of fixing it, the aſhes of which contain much alkaline ſalt, burn vigorouſly and produce much heat; whereas the coals of animal matters, the ſaline principles of which are volatile, and cannot be fixed but in ſmall quantity, and the aſhes of which contain little or no alkaline ſalt, are ſcarcely at all combuſtible. For they not only do not kindle ſo eaſily as charcoal does, nor ever burn alone, but they cannot be reduced to aſhes without very great trouble, even when the moſt effectual methods are uſed to facilitate the combuſtion.

I have kept the coal of bullock's blood very red-hot in a ſhallow crucible, ſurrounded with burning charcoal, ſix hours and more, and ſtirred it conſtantly that it might all be expoſed to the air, but I could not reduce it to white or even grey aſhes. It remained ſtill very black and full of phlogiſton.

The coals of pure oils, or of concrete oily ſubſtances, and ſoot, which is a kind of coal raiſed during the inflammation of oils, are as difficultly burnt as animal coals. Theſe coals contain very little ſaline matter, and their aſhes furniſh no alkali.

Theſe coals, which are ſo difficultly burnt, are alſo leſs capable of inflaming with nitre than others more combuſtible; and ſome of them even in a great meaſure reſiſt the action of nitre.

The refractory quality of coals is a ſingular property. This property is in ſo great a degree, that they are found to be the fitteſt ſubſtances for ſupporting bodies expoſed to the focus of large burning-glaſſes. Nevertheleſs all coal is compoſed of an earth which is not perfectly refractory, of a ſaline matter which is fuſible and aſſiſts the fuſion of other ſubſtances, and of phlogiſton which is certainly the principle of the fuſibility of metals, as their earths become ſo much more difficult to fuſe as they are more dephlogiſticated. *(n)*

COAL (FOSSIL). *(o)*

COATING. *(p)*

COBALT.

(n) To *make charcoal*, or vegetable coal, pieces of wood are ſo diſpoſed as to form a pile, generally conical, which pile is covered with turf to prevent the too free draught of air, by which the wood would be reduced to aſhes and not to coal. The pile is then to be kindled, and the fire is to be continued till all the watery and the more volatile parts of the wood are diſſipated; that is, till no more ſmoke ariſes, at which time the wood is thoroughly red-hot. The external air is then to be totally excluded, by covering the pile with earth, and thus the fire is extinguiſhed.

(o) Coal (Fossil), or Pit-Coal, is a black or brown, laminated, bituminous ſubſtance, not very eaſily inflammable, but which once inflamed, burns longer and more intenſely than any other ſubſtance. Of this ſubſtance three kinds are diſtinguiſhed by authors. The reſiduum of the firſt after combuſtion is black; the reſiduum of the ſecond is ſpongy, and like pounce ſtone; and the reſiduum of the third is whitiſh aſhes. Some foſſil coal, by long expoſure to air, falls into a greyiſh powder, from which alum may be extracted. Foſſil coal by diſtillation yields, 1. a phlegm or water; 2. a very acid liquor; 3. a thin oil like naphtha; 4. a thicker oil, reſembling petroleum, which falls to the bottom of the former, and which riſes with a violent fire; 5. an acid concrete ſalt; 6. an inflammable earth remains in the retort. Theſe conſtituent parts of foſſil coal are very ſimilar to thoſe of amber and other bitumens. *See* Bitumen. For the exciting of intenſe heats, as of furnaces for ſmelting iron-ore, and for operations where the acid and oily vapors would be detrimental, as the drying of malt, foſſil coals are previouſly charred, or reduced to *coaks*; that is, they are made to undergo an operation ſimilar to that by which charcoal is made. By this operation coals are deprived of their phlegm, their acid liquor, and of greateſt part of their fluid oil. Coaks therefore conſiſt of the two moſt fixed conſtituent parts, the heavy oil and the earth, together with the acid concrete ſalt, which though volatile is detained by the oil and earth.

(p) Coating, or Lorication, is an application of clay, or mixture of clay with ſand or other ſubſtance, to the external or internal ſurfaces of chemical veſſels, to guard them againſt the

COBALT. This name is given by authors to ſeveral different minerals. We ſhall here only talk of that kind of cobalt which contains the metallic matter whoſe calx furniſhes a blue glaſs when vitrified; becauſe the name *cobalt* ought to be confined to this mineral alone, to avoid the uncertainty and confuſion too frequent in names of natural hiſtory and of chemiſtry.

Cobalt is a very heavy mineral, of no determinate figure; of a grey color, more or leſs brilliant; of a fine, compact, cloſe grain, the ſurface of which, when it has been expoſed to the air, is covered with a powder, or effloreſcence of the color of a peach-bloſſom.

This mineral is not found in many places. Hitherto it ſeems to have been found only in Saxony and in the Pyrenean mountains (q). It contains ſeveral ſubſtances mixed and

effects of ſudden heat, or of the corroſive quality of the matter to be contained. Thus glaſs retorts intended to be expoſed to what is called a naked fire, that is, to a fire without interpoſition of a ſand-bath or other ſubſtance, ought to be externally coated, by which means they will not be ſo liable to be cracked by the ſudden application of heat and cold. Retorts may be coated in the following manner: Take of clay and ſand equal parts; make them into a thin paſte, with freſh blood prevented from coagulating by agitation till it be cold, and diluted with water; add to this paſte ſome hair and powdered glaſs; with a bruſh dipt in this maſs beſmear the retort; and when this firſt layer is dry, let the ſame operation be repeated twice or oftener, till the coat applied be about one-third part of an inch thick. For the compoſitions for coating crucibles, furnaces and other inſtruments made of plate-iron, *ſee* CRUCIBLE.

(q) Cobalt has been found in Cornwall, Scotland, and probably in other parts of Europe. That it is in the eaſtern parts of Aſia, appears from the blue coloring on old oriental porcelain. Probably alſo the mines diſcovered in theſe countries are nearly exhauſted, as conſiderable quantities of zaffre and ſmalt are exported from Europe to China. Beſides the grey or aſh-colored cobalt deſcribed in the text, which is the moſt frequent, other cobalts are found of various colors and textures, mixed with various ſubſtances. Wallerius enumerates ſix ſpecies of cobalts. 1. The *aſh-colored ore*, which is regulus of cobalt mineraliſed by arſenic, conſiſting of ſhining leaden-colored grains. Some ores of this kind are compact, reſembling ſteel, and others are of a looſe texture and friable. 2. The *ſpecular ore* is black, ſhining like a mirror and laminated. This ſpecies is very rare, and is ſuppoſed by Wallerius to be a foliated ſpar, or ſelenites mixed with ore of cobalt and confounded together, and in this reſpect ſome cobalts differ from others. All of them contain ſulphur, much arſenic, and the ſemi-metal the calx of which may be made into blue glaſs, and which Mr. Brandt of the Swediſh Academy calls *Regulus of Cobalt* when it is reduced to its metalline ſtate. Beſides theſe ſubſtances, ſome cobalts contain biſmuth, ſilver, or both of theſe.

Of all theſe matters, the peculiar regulus of cobalt renders this mineral valuable from the fine blue which is manufactured from it, and which is the only blue that can be uſed in vitrification.

Nevertheleſs other ſubſtances are collected from cobalt in the operations practiſed on it, but only ſecondarily, becauſe theſe ſubſtances may be obtained without additional labor or expence. For example, as it is neceſſary in the preparation of the blue to expel the arſenic, this mineral muſt be expoſed to long roaſtings; inſtead of diſſipating the arſenic which riſes in vapors during the torrefaction, it is collected in long crooked chimneys, adapted to the furnaces in which the cobalt is roaſted, and thus is obtained almoſt all the arſenic which is ſold in commerce. *See* ARSENIC.

Likewiſe after the roaſting, when the calx of cobalt is fuſed with vitrifiable matters to make the blue glaſs called *Smalt*, the biſmuth and ſilver may be ſeparated and collected.

cobalt. 3. The *vitreous*, or *ſlag-like ore*, is of a blueiſh, ſhining color, compact, or ſpongy. 4. *Cryſtallized ore of cobalt* is a grey, deep-colored ore of cobalt, conſiſting of cluſters of cubical, pyramidal, priſmatic cryſtals. 5. *Flowers of cobalt*, red, yellow, or violet. Theſe flowers ſeem to be formed from ſome of the above deſcribed compact ores, decompoſed by expoſure to moiſt air. This decompoſition is ſimilar to that which happens to ferruginous and cupreous pyrites. 6. The *earthy ore of cobalt* is of a greeniſh white or of a yellow color, and of a ſoft and friable texture. This ſpecies ſeems to be an ochre of cobalt, and is formed perhaps from the flowers of cobalt further decompoſed, in the ſame manner as a martial ochre is formed from the ſaline efflореſcence of decompoſing pyrites, when this eflloreſcence is further decompoſed by expoſure to moiſt air; by which the vitriolic acid contained in it is expelled, and the eflloreſcence is changed from a ſaline ſtate to that of an ochre or calx. Beſides theſe proper ores of cobalt, it is alſo found in a blue clay along with native ſilver, in ores of biſmuth, and in the mineral called kupfernickel. *See* NICKEL.

The ſilver, although a valuable metal, is generally in ſo ſmall a quantity, that it would not be worth the trouble of obtaining on purpoſe from this mineral. The cobalt is therefore always operated upon for the ſake of the blue.

If well-calcined cobalt be treated with phlogiſton and fluxes, like other metallic calxes, it will be reduced to a ſemi-metal, called by Mr. Brandt, who firſt diſcovered it, the *Regulus of Cobalt*.

This regulus, and alſo the calx of cobalt, amongſt other ſingular properties, has that of making a very curious ſympathetic ink, by being diſſolved in aqua regia. *See, for what further relates to cobalt, the articles* SMALT, ZAFFRE, AZUR, REGULUS *of* COBALT, *and* INK (SYMPATHETIC).

COCHINEAL. *(s)*

COERULEUM MONTANUM. *(s)*

COHESION. By coheſion is meant the adheſion which the integrant or the conſtituent parts of bodies have to each other.

(r) COCHINEAL. From an ounce of cochineal Neuman obtained by diſtillation two ſcruples of phlegm, four ſcruples of urinous ſpirit, fifteen drops of oily ſpirit, twenty-two grains of volatile alkali, five ſcruples and two grains of empyreumatic oil, and two drams and two ſcruples of a reſiduum containing five grains of fixt lixivial ſalt. The ſame author found that of four drams of cochineal, three drams were ſoluble in water, and nearly as much in ſpirit of wine.

Cochineal infuſed or boiled with water produces a crimſon tincture inclining to purple. Fixed alkali renders the crimſon deeper, but leſſens its luſtre. Volatile alkali heightens the color without diminution of luſtre.. The beſt method of applying volatile alkali for this purpoſe in dying was found by Mr. Hellot to be, by dipping the cloth dyed with cochineal in a ſolution of ſal ammoniac, and then throwing into the ſolution ſome potaſh, by which the volatile alkali of the ſal ammoniac is diſengaged. By a ſmall quantity of vitriolic acid the crimſon decoction of cochineal is rendered purple, by more of that acid it is rendered fleſh-colored, and by ſtill more colorleſs. This color is firſt changed to a yellow, and afterwards deſtroyed by nitrous acid. Solution of tin in aqua regia heightens the color of this decoction to a ſcarlet. French dyers give a ſcarlet tinge to this decoction by turmeric; but this tinge does not penetrate the cloth, and is not durable. *See* DYING.

(s) COERULEUM MONTANUM, *mountain-blue*, called by ſome authors *chryſocolla*, is a blue ore of copper. *See* ORES *of* COPPER.

COHOBATION. Cohobation is an operation by which the ſame liquor is frequently diſtilled from the ſame body, either with an intention to diſſolve this body, or to produce ſome change upon it. This is one of thoſe operations which the ancient chemiſts practiſed with great patience and zeal, and which are now neglected.

To make this operation eaſier, and to prevent the trouble of frequently changing or moving the veſſels employed, a particular kind of alembic is contrived, very convenient and well adapted, called a *Pelican*. *See* PELICAN.

COLCOTHAR. Colcothar is the ſubſtance which remains from the calcination and diſtillation of martial vitriol with a violent fire.

Vitriolic acid does not adhere ſo ſtrongly to the iron of the martial vitriol as to be capable of reſiſting the action of a ſtrong fire; therefore when this vitriol is heated intenſely and during a long time, it loſes more and more of its acid, which is diſſipated if the calcination be performed in open veſſels, and which may be diſtilled with a proper apparatus. When the vitriol loſes its acid, it acquires a red color, and becomes an earthy matter. The calx of iron, whether it has been deprived of phlogiſton by fire or by acids, is always of this red color: but the iron contained in vitriol ſuffers this alteration during the calcination. When the calcination is finiſhed, what remains of the vitriol has ſtill ſome taſte, and even the property of becoming moiſt when expoſed to air. Theſe qualities are cauſed by ſome remaining acid which adheres obſtinately to the earth of the iron, and which the fire could not expel. As this acid is very much concentrated, and is not combined with the calx of iron in the colcothar, as it was with the iron itſelf in the vitriol, becauſe the phlogiſton of the iron is loſt by calcination, we need not wonder that this calcined vitriol ſhould powerfully imbibe moiſture from the air, although the uncalcined vitriol does not.

This remaining acid may be taken from the colcothar by waſhing with water. The colcothar then has no taſte, does not attract moiſture from the air, and is called *Sweet Earth of Vitriol.*

Unwaſhed colcothar is uſed in medicine, but only externally. It may be properly applied to all putrid, ſanious and fungous ulcers, becauſe it is antiſeptic, ſtrongly tonic, aſtringent, and even corroſive, from its remaining uncombined vitriolic acid. *See* VITRIOL (MARTIAL) *and* CALCINATION.

COLOPHONY. Colophony, or roſin, is the reſinous reſiduum after the diſtillation of the light oil from turpentine. It has alſo the properties of other reſins, and the ſame principles may be obtained from it by analyſis. *See* BALSAMS (NATIVE); TURPENTINE; *and* RESIN.

COLORS. *(t)*

COMBINATION. By the word *combination*, we ought to underſtand the union of two bodies of different natures, from which a new compound body reſults. For example, when an acid is united with an alkali, we ſay that a combination betwixt theſe two ſaline ſubſtances takes place, becauſe from this union a neutral ſalt reſults which is compoſed of an acid and an alkali. *See* COMPOSITION.

COMBUSTION. Combuſtion is nothing elſe than the diſengagement of the inflammable principle contained in ſeveral kinds of bodies, which are therefore called *combuſtible*.

The principle of inflammability is united in greater or leſs quantity with bodies, and in ſeveral different manners; hence the diverſity occaſioned in the phenomena of combuſtion.

If the phlogiſton of a body be in large quantity, and in an oily ſtate, this body is very combuſtible, and burns with a bright flame, accompanied with ſmoke and ſoot. Wood, dry vegetables, reſins, oils, fat, are combuſtible bodies of this kind.

If the phlogiſton of a body be not in an oily ſtate, but in large quantity, or not very intimately combined, this body may alſo be very combuſtible, and may even burn with flame. But this flame is ſlighter and generally leſs luminous than the flame of oily bodies; beſides, it is accompanied with no ſmoke or ſoot. Spirit of wine, ſulphur, phoſphorus, charcoal, ſome metallic matters, and particularly zinc, are combuſtible bodies of this kind. The flames of phoſphorus and of zinc are nevertheleſs very luminous.

Laſtly, bodies containing phlogiſton which is not in an oily ſtate, and which is in ſmall quantity, or ſtrongly combined with other uncombuſtible principles, burn difficultly without any ſenſible flame; ſuch are certain animal coals, ſoot, aſhes of vegetables containing very little phlogiſton, and imperfect metals.

The grand principle concerning combuſtion in general is, that no combuſtible matter can burn without acceſs of air,

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(t) Colors. See BLACK, BLUE, &c. *and* DYING.

and that the more immediate its contact with air is, the more rapid and complete is its combuſtion. *See* AIR.

For this reaſon, even the moſt inflammable bodies, as ſpirit of wine and ethereal oils, do not burn but at their ſurface, becauſe that only is expoſed to air. For the ſame reaſon, inflammable bodies, when reduced to vapor, burn rapidly and inſtantaneouſly, becauſe they are all expoſed to air at once. Laſtly, for the ſame reaſon, ſome bodies, though full of phlogiſton, ſuch as fat, oils, &c. cannot burn without a heat ſufficient to reduce them into vapor.

The practical methods of promoting, accelerating, and of completing the combuſtion of the inflammable principle of bodies may alſo be naturally deduced from what we have ſaid on this ſubject. Theſe methods conſiſt in applying as much of theſe bodies as poſſible to the air. Thus by directing a current of air upon the burning bodies, their combuſtion is accelerated and augmented in proportion as this current is ſtronger, as the effects of bellows and air-furnaces evidently prove.

Moſt oily bodies, as wood, burn with much flame, which laſts while any ſenſible quantity of oil remains: after which the flame ceaſes. They are not however yet deprived of all their inflammable principle, a part of which remains in the ſtate of coal. Then the remaining part of the body may continue to burn, if it contains much phlogiſton, but without a luminous flame, and in the manner of charcoal.

In proportion as the phlogiſton is conſumed by this ſecond combuſtion, what remains of it becomes more and more difficultly combuſtible; not only becauſe the leaſt fixed and adherent part of it is firſt burnt, but alſo becauſe the proportion of incombuſtible matter, to which this phlogiſton is united, becomes greater and greater. Hence when this combuſtion has arrived at a certain point, that is, when a ſmall portion of phlogiſton only remains ſtrongly combined, and alſo covered and defended by a large quantity of incombuſtible matter, this remaining phlogiſton will not burn alone, and is nearly in the ſame ſtate as that of moſt metallic matters. If, therefore, this combuſtion is to be compleated, which then is called *calcination*, fire muſt be applied from ſome other fuel, with which the body to be calcined or dephlogiſticated is to be penetrated, and kept red-hot; and as much air is at the ſame time to be applied to the body, till no longer any marks appear of its inflammable principle. Aſhes of vegetables, ſoot, coals of oils and of animal matters, and ſeveral metallic ſubſtances, contain ſome phlogiſton in this laſt ſtate.

When the phlogiſton of theſe ſubſtances is to be entirely burnt or diſſipated, all the means capable of favouring combuſtion ought to be made to concur. The ſubſtances ought to be firſt divided into very ſmall parts, becauſe then they preſent more ſurface to the air than when in one maſs. They are then to be expoſed to the action of fire in a convenient veſſel, ſo that the air may have free acceſs; as for example, in a wide-mouthed teſt, and under a muffle open on the ſide at which air is introduced into the furnace. To accelerate further this operation, a current of air may be directed upon the ſurface of theſe bodies, and they may be frequently ſtirred, that all their parts may be ſucceſſively preſented to air. The ſtrongeſt fire which the matter can ſuſtain without fuſion ought to be applied; becauſe a melted body forms always one maſs, and preſents leſs ſurface than when it is divided in ſmall detached parts. Thus fuſible bodies, as aſhes, alkaline ſalts and metals, ought to be calcined with a moderate heat, and proportioned to their fuſibility.

The laſt portions of the phlogiſton of certain bodies are ſo difficultly combuſtible, that notwithſtanding all theſe means united, they never can be entirely burnt.

Some of them even, as the perfect metals, are conſidered as bodies entirely incombuſtible, becauſe they can ſuſtain the moſt violent fire during entire months, without ſuffering any ſenſible alteration. Neverthele ſs, Junker affirms, that gold and ſilver may be calcined, if they are treated during ſix months, by reverberation, in the manner of Iſaacus Hollandus.

Although the certainty of this experiment has not been ſufficiently confirmed by repeated trials, the method of calcining theſe metals propoſed by this chemiſt agrees ſo well with the great principles of combuſtion, that its ſucceſs ſeems very probable. *See* CALCINATION.

COMPOSITION *of* BODIES. Chemical compoſition is the union and combination of ſeveral ſubſtances of different natures, from which a compound body reſults. From this union of bodies of different natures a body is formed of a mixed nature, which Becker and Stahl have called a *mixture*, and which may be called a *combination* or *chemical compoſition*, to avoid the equivocal ſenſe of the word *mixture*, by which may be underſtood only a mere interpoſition of parts, and which therefore would give a very

falſe

ſalſe idea of chemical compoſition, in which a mutual adheſion takes place between the combined ſubſtances.

When the ſubſtances conſidered by chemiſts as *ſimple*, or *primary principles*, are combined together, they form the firſt compounds, to which Becker and Stahl give, by way of excellence, the name *Mixts*. The ſame chemiſts call the bodies formed from the union of theſe mixts, *compounds*. When they treat of more complicated combinations, they talk of *decompounds* and *ſurdecompounds*.

This diſtribution of bodies, more or leſs compounded, is juſt and conformable to experience. But the names given by Becker and Stahl are not ſufficiently clear and accurate.

A more ſimple and clear method of diſtinguiſhing theſe ſeveral claſſes of bodies ſeems to be by numbers indicating their degree of compoſition. Thus we might ſay, compounds of the firſt, of the ſecond, of the third degree, &c. as Mr. Macquer propoſes in his courſe of chemiſtry.

CONCENTRATION. The concentration of a body conſiſts in approximating its proper and integrant parts, by taking away ſome ſubſtance interpoſed betwixt theſe parts, and which is extraneous or ſuperabundant to the body to be concentrated. Thus, for inſtance, a ſolution of any ſaline ſubſtance in water may be concentrated by expelling part of the water of this ſolution. But cuſtom has applied the word concentration to the dephlegmation of acids, and particularly of vitriolic acid by diſtillation, and of vinegar by congelation. We proceed to both theſe concentrations.

CONCENTRATION *of* VITRIOLIC ACID. Vitriolic acid, procured either from vitriol or from ſulphur, is never ſufficiently pure for chemical operations. It always contains ſome extraneous ſubſtances from which it muſt be purified.

The heterogeneous matters which chiefly affect the purity of vitriolic acid, are ſuperabundant water by which it is weakened, and inflammable matter by which it is rendered black and ſulphureous. Theſe two ſubſtances are ſeparable by one and the ſame diſtillation, which is called the *concentration*, or the *rectification of vitriolic acid*. This acid ought to be diſtilled, whether it be both watery and ſulphureous, or have only one of theſe faults.

To explain what paſſes in this operation, and the management which muſt be obſerved, we will firſt conſider what happens in the concentration of vitriolic acid, which is only diluted with ſuperabundant water, and not phlogiſticated.

giſticated. We will then proceed to the changes produced upon this acid by diſtillation, when it is ſufficiently free from water, and is only phlogiſticated.

When vitriolic acid, diluted with ſuperabundant water, is to be concentrated, if it contains a conſiderable quantity of water, it may be diſengaged from the greateſt part of this ſuperfluous water in ſtone or glaſs bottles, without the apparatus of diſtillation. The greater the quantity of water which is united with the vitriolic acid, the leſs ſtrongly does a part of it adhere. As this water is much more volatile than vitriolic acid, it evaporates by almoſt the ſame degree of heat which is requiſite to the evaporation of pure water. While the water exhales, the parts of the vitriolic acid remaining in the veſſel are approximated, and the acid becomes more and more concentrated and ſtrong. Thus the operation proceeds very well to a certain point, and even better than by diſtillation. But when the acid has arrived at a certain degree of concentration, it cannot be completed in open veſſels; becauſe the ſmaller which the quantity is of water united to the acid, the more ſtrongly it adheres; ſo that it cannot be ſeparated without a heat ſufficient to raiſe alſo the acid, which therefore in open veſſels would be loſt. But another and more remarkable inconvenience occurs, which is, that when vitriolic acid begins to be much dephlegmated and very ſtrong, it becomes ſo greedy of moiſture that it attracts that of the ſurrounding air, as Mr. Beaumé has well obſerved, and perpetually combines with it; ſo that every inſtant it reſumes as much water from the air as it loſes by evaporation. The concentration of this acid muſt therefore be completed in cloſe veſſels by diſtillation.

For this diſtillation, a retort of good glaſs, capable of reſiſting acids, muſt be filled half full with the vitriolic acid to be concentrated, and ſet in a ſand-bath covered entirely with ſand. After a receiver has been adapted to it, heat muſt be applied, and very gradually augmented till drops are diſtilled.

If the vitriolic acid contains little water, the diſtillation does not begin but with a conſiderable degree of heat, and the drops which fall into the receiver are very acid. Theſe drops fall very ſlowly, and the diſtillation muſt not be too much haſtened. As the concentration advances, the drops follow each other at longer intervals, although the acid contained in the retort acquires more and more heat. Towards the end of the operation, and when the acid is much concentrated, care muſt be taken not to encreaſe the heat ſo much as to make the acid boil, which cannot be effected with leſs than a red heat. By this heat all the acid may be raiſed at once, in drops and burning vapors, which paſs precipitately, and generally burſt the retort.

When this accident happens, whether it proceeds from haſtening the diſtillation too much, or from cold air ſtriking the retort, the concentrated and burning acid is almoſt entirely reduced to white, thick, ſuffocating vapors which inſtantly fill the laboratory.. The operators ought to remove themſelves from ſuch hurtful vapors.

The duration of this operation, and the quantity of phlegmatic acid to be diſtilled, ſo that the vitriolic acid ſhall be left highly concentrated, are abſolutely indeterminate, as they depend on the degree of ſtrength which this acid had before its concentration. The vitriolic acid, which was formerly kept by druggiſts, required that one half of it ſhould be drawn off by diſtillation to make the remaining part twice as heavy as water. At preſent, it is much ſtronger, although cheaper. Some may be got very concentrated, and which only requires to be dephlogiſticated in the manner deſcribed below.

The vitriolic acid manufactured in the great, and ſold in commerce, is always mixed with more or leſs inflammable matter, by which it is rendered black and opake. It may be entirely diſengaged from this extraneous matter by a diſtillation ſimilar to that above deſcribed.

The firſt portions of ſuch an acid which paſſes in diſtillation are a very penetrating, volatile, ſulphureous acid. If the phlogiſticated vitriolic acid which is rectified be alſo phlegmatic, the diſtillation may be ſo managed that the liquor ſhall ſlightly boil. This liquor continues black till it is concentrated to a certain degree; when by help of a ſtrong heat which it then acquires, the concentrated acid acts upon the inflammable matter, diſſipates it, or completely burns it. The liquor in the retort becomes gradually clearer, and at length perfectly white and tranſparent. If this acid has alſo the requiſite degree of concentration, the operation is finiſhed when the liquor thus becomes perfectly white and tranſparent. The retort muſt be left in the ſand-bath till it is cold, and then the acid is to be poured into a clean, dry, cryſtal-glaſs bottle; becauſe the ſmalleſt piece of inflammable matter is capable of phlogiſticating and blackening rectified vitriolic acid; and becauſe any moiſture, beſides weakening the acid, might occaſion ſuch heat as to break the bottle. When the acid is poured into the bottle, the neck of this bottle ought to be wiped dry, and cloſed by a glaſs ſtopper, accurately fitted and well wiped. The mouth of the bottle ought alſo to be guarded from duſt by being covered with leather.

The phlegmatic or ſulphureous liquor, which paſſed over into the receiver, is called *Spirit of Vitriol.* It is clear and white, and may be uſed in many operations where concentrated vitriolic acid is not requiſite, or it may be concentrated and rectified.

CONCENTRATION *of* VINEGAR *by* CONGELATION. Vinegar produced by the acetous fermentation is a vegetable acid much uſed in chemiſtry. As this acid is mixed with much extractive matter and ſuperabundant water, chemiſts have endeavoured to render it more pure and ſtrong.

It may eaſily be diſengaged by a ſingle diſtillation from almoſt all its extractive matter; *ſee* VINEGAR (DISTILLED); but it cannot ſo eaſily be deprived of its ſuperabundant water. If vinegar be diſtilled with intention to concentrate it, as vitriolic acid is, the moſt watery and leaſt acid part would always riſe firſt; but the operation would ſucceed very imperfectly, becauſe this acid is almoſt as volatile as water. To procure the concentration of vinegar, other expedients muſt be uſed. Chemiſts have diſcovered ſeveral which ſucceed well. For inſtance, by combining this acid with fixed matters, ſuch as fixed alkalis and metals, and afterwards ſubjecting to diſtillation the ſalts reſulting from ſuch combinations, a very concentrated acid of vinegar is obtained, called, *Radical Vinegar. See upon this ſubject* TERRA FOLIATA TARTARI, SALT *of* LEAD, CRYSTALS *of* VERDIGRISE, *and* VINEGAR (RADICAL). We proceed here to deſcribe another method of concentrating vinegar, by which indeed it cannot be ſo much dephlegmated as by the preceding methods, but it is much more ſimple, and has ſome peculiar advantages. The method is affected by congelation, or freezing.

Stahl ſeems to be the firſt who employed this method. Since which time Mr. Geoffroy has made many experiments on this ſubject, a relation of which is to be found in the Memoirs of the Academy for the year 1739.

As acids reſiſt congelation much more than water, if vinegar be expoſed to a cold ſufficient to ſink the mercury of Mr. Reaumur's thermometer eight or ten degrees below the figure 0, a conſiderable quantity of ice will be formed.

This ice, being ſeparated from the reſt of the unfrozen liquor, conſiſts of ſcarcely any thing but pure water; and the unfrozen liquor is a much ſtronger vinegar. By expoſing again this vinegar to another and ſtronger froſt, more ice is formed in it, leſs hard than the firſt ice, and ſomewhat reſembling ſnow, becauſe it contains a certain quantity of unfrozen acid; and may therefore be ſet aſide for the extraction of this acid. The acid remaining after the ſecond congelation is greatly ſtronger. This concentration of vinegar may be much encreaſed by repeating the congelation with greater cold. Mr. Geoffroy relates in the quoted memoir, that vinegar which has been already concentrated by froſts of preceding years, and eight pints of which had been reduced to two pints and a half by the froſt of January 29, 1739, was at length ſo much concentrated, that two drams of this vinegar, the ſaturation of which before theſe concentrations would have required ſix grains of ſalt of tartar, did now require forty-four grains for that purpoſe.

Stahl aſſures us, that wine may be well concentrated by the ſame method. He ſays, that he expoſed to froſt different kinds of wine, and that he had procured by this means two thirds, or three quarters of pure phlegm.

Wines thus concentrated had a thick conſiſtence, were very ſtrong, and were preſerved without change many years, in places, where the free acceſs of air, alternately hot and cold, according to the ſeaſons, would have ſoured or ſpoiled any other wine in a few weeks. The general opinion that wines are ſpoiled and entirely weakened by froſt proceeds undoubtedly from the ice not being taken off, but left to mix again with the wine when it thaws. Perhaps alſo ſome delicate wines are conſiderably altered by froſt.

Wallerius ſays, that, in the northern countries, cold is ſucceſsfully uſed to concentrate ſea-water, and to approximate the particles of ſalt, by ſeparating the ice as ſoon as it is formed, and which is little elſe but pure water.

We might be induced to believe that the mineral acids might be concentrated by congelation, as indeed they might be, if they were mixed with a very great quantity of water: but their adheſion to water is ſo ſtrong, that they cannot be much concentrated by this method.

CONDENSATION. By the condenſation of a body we ought to underſtand the approximation of its integrant parts, ſo that it occupies a ſmaller ſpace, and that its ſpecific gravity is augmented, without the loſs of any heterogeneous matter. For inſtance, air, forced by compreſſion to confine itſelf within a narrower ſpace, is to be conſidered as condenſed.

CONE. (*u*)

CONTRAYERVA. (*x*)

COPAL. (*y*)

COPPER. Copper, called alſo by chemiſts *Venus*, is an imperfect metal of a red ſhining color. It is harder, more elaſtic and ſonorous, but a little leſs ductile than ſilver. It is nevertheleſs conſiderably ductile, and may be drawn into wire as fine as hair, or beaten into leaves almoſt as thin as thoſe of ſilver.

(*u*) Cone (Melting). This is a hollow cone formed of copper or of braſs, with a handle, and with a flat bottom adjoining to the apex of the cone, upon which it is intended to reſt. Its uſe is to receive a maſs of one or more metals melted together and poured into it. This maſs when cold may be eaſily ſhook out of the cone, from the figure of the veſſel. Alſo if a melted maſs, conſiſting of two or more metals, or other ſubſtances not combined together, be poured into this veſſel, the conical figure facilitates the ſeparation of theſe ſubſtances according to their reſpective denſities. The cone ought to be well heated before the melted maſs is poured into it, that no moiſture may be contained, by which a dangerous exploſion might be occaſioned. It ought alſo to be greaſed internally with tallow, to prevent the adheſion of the fluid matter.

(*x*) Contrayerva. The leaves of this plant are ſaid to afford a poiſon employed by Indians for poiſoning arrows, to which poiſon the root of the ſaid plant is ſaid to be an antidote. From an ounce of the root Neuman extracted, with water, three drams and half a ſcruple; and from the ſame quantity, with ſpirit of wine, five ſcruples and two grains.

(*y*) Copal, improperly called *gum copal*, is a hard, ſhining, tranſparent, citron-colored, odoriferous, concrete juice of an American tree, but which has neither the ſolubility in water common to gums, nor the ſolubility in ſpirit of wine common to reſins, at leaſt in any conſiderable degree. By theſe properties it reſembles amber. It may be diſſolved by digeſtion in linſeed oil, with a heat very little leſs than ſufficient to boil or decompoſe the oil. This ſolution, diluted with ſpirit of turpentine, forms a beautiful tranſparent varniſh, which, when properly applied, and ſlowly dried, is very hard and very durable. This varniſh is applied to ſnuff-boxes, tea-boards, and other utenſils. It preſerves and gives luſtre to paintings, and greatly reſtores the decayed colors of old pictures by filling up the cracks, and rendering the ſurfaces capable of reflecting light more uniformly.

The tenacity of the parts of this metal is very conſiderable, ſince a copper wire, the diameter of which is a tenth part of an inch, is capable of ſupporting a weight of $299\frac{1}{4}$ pounds without breaking.

Copper weighed by the hydroſtatical balance loſes in water about an eight or a ninth part of its weight *(z)*. It has a very ſingular and diſagreeable ſmell and taſte. It cannot be fuſed without a violent degree of heat ſufficient to make it white.

Copper, being an imperfect metal, may be burnt, deſtroyed, and calcined by the united action of fire and air: for which reaſon its quantity is always diminiſhed by melting it without covering its ſurface.

When it is expoſed to a great fire with free acceſs of air, it ſmokes, loſes part of its weight, and communicates to flame beautiful green and blue colors.

It reſiſts more than any other imperfect metal the action of fire before it ſuffers any conſiderable alteration. When a clean and poliſhed copper plate is gently and gradually heated, its ſurface is covered with all the colors of the rainbow. This appearance proceeds from the developement, and the different ſtates of the phlogiſton of the metal. *(a)*

When this metal is expoſed to red heat with contact of air, its ſurface becomes quickly tarniſhed, and its metallic luſtre is changed into a dark and earthy appearance; and if this heat be continued during a certain time, the ſurface of the metal is burnt and deſtroyed; ſo that when it cools, it is found to have no longer any adheſion with the uncalcined copper, but to be ſeparated in ſcales from the

(z) The ſpecific gravity of European copper is to that of water as 8843, and of Japaneſe copper as 9000 to 1000.

(a) All calcinable metals are ſubject to receive theſe colors or iriſes by heat; and from the color of any part of a piece of metal we may diſcover what degree of heat has been applied to that part, as the ſame degree of heat always gives the ſame color to the ſame metal: hence artiſts, by obſerving the colors acquired by ſteel expoſed to fire, are enabled to apply to pieces of that metal the preciſe degree of heat which they have found by experience to produce the required hardneſs, in the operation of tempering ſteel. The iriſes, or different colors given to different parts of one piece of metal, are occaſioned by the heat being unequally applied. Theſe colors are produced by a more or leſs perfect calcination of the ſurface of the metal expoſed to heat.

difference of the contraction, occaſioned by cooling, upon the uncalcined copper, and upon its burnt ſurface.

When this ſurface is ſeparated, the copper beneath it ſeems clean and ſhining; but it will ſoon ſuffer the ſame change as the former, if it be again heated; and thus a piece of copper may be entirely reduced to ſcales no longer poſſeſſed of brilliancy, ductility, or other metallic properties, and which are called *burnt copper.*

This calcined copper is leſs fuſible than copper in its metallic ſtate: when expoſed to a great fire, but a very ſmall quantity of copper is obtained from it; the reſt of it is changed into a dark and opake vitrified ſcoria; except the ſcales have been mixed with ſome matter capable of reſtoring to them phlogiſton; in which latter caſe a quantity of malleable copper is obtained nearly equal to that of the ſcales employed. *See* REDUCTION *of* METALS.

Theſe copper ſcales, which are at firſt but imperfectly calcined, may be entirely deprived of phlogiſton and of their metallic properties by a ſecond calcination under a muffle continued ſufficiently long.

Copper is alſo affected by the combined action of air and water: hence its ſurface is apt to tarniſh, and even to be covered with a green ruſt, called *verdegriſe.*

This ruſt is copper partly decompoſed, and deprived of part of its inflammable principle; for it cannot be melted into copper without much loſs, excepting its phlogiſton be reſtored by ſome reductive flux. Theſe are alterations to which all the imperfect metals are ſubject. *See* METALS (IMPERFECT).

This metal is eaſily ſoluble by all acids, and its ſolutions are green or blue. *(b)*

Vitriolic acid, although the ſtrongeſt of all, diſſolves copper more difficultly than any other: it muſt be concentrated and aſſiſted by conſiderable heat and time to diſſolve this metal. From this ſolution reſults a neutral ſalt, which forms beautiful blue cryſtals, called *blue vitriol,* or *vitriol of copper. See theſe words.*

Nitrous acid diſſolves copper very quickly with violence and effervеſcence; and during the ſolution it takes from the

metal

(b) Solutions of copper in vitriolic acid, vegetable acid, oil, or water, are green; that in marine acid is at firſt brown or yellow, and becomes afterwards green; and that in aqua fortis is of a bluiſh-green color: volatile or fixed alkalis make the ſolutions of copper in acids blue: a ſolution of copper in volatile alkali, expoſed to air, is blue.

metal part of its phlogiſton. The nitre formed by this ſolution is a very deliqueſcent ſalt. The ſalts formed by marine acid or by aqua regia with copper are alſo very deliqueſcent.

Vegetable acids, and particularly thoſe of wine and of vinegar, may be eaſily united with copper. The former acid forms with it the verdegriſe uſed in painting (*See* VERDEGRISE); and the ſecond, when ſaturated, forms the ſalt called *cryſtals of verdegriſe*, or *cryſtal of Venus*. *See* CRYSTALS *of* VERDEGRISE.

All acids united with copper may be ſeparated from it without any intermediate ſubſtance, and merely by fire.

Calcareous earths, fixed and volatile alkalis, ſeparate copper from any acid, and precipitate it in form of a beautiful green powder. The color of thoſe precipitates or copper is cauſed by a portion of the ſalts which remain united with them. As the metal thus diſſolved and precipitated has loſt part of its phlogiſton, particularly when it has been diſſolved by vitriolic and nitrous acids, theſe precipitates of copper cannot be melted into malleable copper without addition of phlogiſton: but if they be melted with glaſſes, or vitreſcible matters, and the fire be properly managed, they communicate their colors to theſe ſubſtances: hence they may be applied to imitate precious ſtones of a green color, or nearly green, as the emerald, and beryl or aqua marina, and for ſeveral ſhades of painting upon pottery and porcelain.

Some metallic matters, which have a ſtronger affinity than copper has to acids, are therefore capable of precipitating this metal from its ſeveral ſolutions. Iron particularly has this property; for which reaſon, if it be added to a ſaturated ſolution of copper in an acid, it will be attacked and diſſolved by this acid, and it will precipitate the copper; and thus the ſolution of copper is changed into a ſolution of iron. While this happens, a remarkable phenomenon appears: the copper thus precipitated is in its metallic ſtate and brilliancy. This effect, which ſeems to be general whenever a metallic matter is ſeparated from an acid by means of another metallic matter, can only happen becauſe the precipitating metal ſeparates entirely and exactly all the acid from the precipitated metal, which earths and alkalis ſeem incapable of doing; and becauſe the precipitating metal ſupplies enough of phlogiſton to the acid, to prevent the acid from retaining the phlogiſton of the precipitated metal, which earths and alkalis are alſo incapable of doing.

However that be, this precipitation of copper in its metallic ſtate, by the intervention of iron, is capable of impoſing upon, and actually has impoſed upon perſons ignorant of chemiſtry; who, perceiving that a piece of iron, dipt into a liquor in which they ſuſpected no copper, became covered over with copper, imagined that this liquor had the property of changing iron into copper.

This property which iron has of ſeparating copper from acids has been applied to uſe. In England, the water in a copper mine is impregnated with a great quantity of blue vitriol, and from which much copper is extracted by means of iron immerſed in it. In Germany ſome copper ores are ſo pyritous, that they cannot be advantageouſly treated by ordinary fuſions, but are reduced into vitriol, and by means of the iron which is put into the lixivium of this vitriol, called *cement water*, a conſiderable quantity of copper is obtained, which would otherwiſe be loſt. *See* ORES, PYRITES, *and* VITRIOLS.

Copper produces, with reſpect to mercury and ſilver diſſolved in acids, the ſame effects which itſelf ſuffers from iron; that is, it ſeparates theſe metals ſo exactly from the acids with which they are united, that they appear with their metallic luſtre.

This property of copper is employed to obtain ſilver diſſolved by ſpirit of nitre in the operation of parting. This ſilver is generally very pure.

If a very clean plate of copper be immerſed in a ſolution of mercury, particularly if this ſolution have an exceſs of acid, it will be very ſoon covered over with mercury, which adheres to it, and which, when wiped and waſhed, makes a very white and brilliant ſilvering. This alſo is one of the experiments which exhibit an appearance of tranſmutation capable of aſtoniſhing thoſe who are ignorant of chemiſtry. Every day credulous perſons are deceived by tricks no better than this.

No metal is more ſoluble than copper. It is acted upon by almoſt all ſaline and metallic ſubſtances, and probably for this reaſon ancient chemiſts have called it *Venus*, conſidering it as proſtituted to all ſubſtances.

Fixed and volatile alkalis eaſily diſſolve copper, either directly, or ſtill better if it has been previouſly diſſolved in acids. *See* ALKALIS (FIXED *and* VOLATILE).

Moſt neutral ſalts corrode its ſurface, and reduce it into verdegriſe. The ſame effect is produced by all oils and fat matters, from the latent acid which they contain.

Sulphur has conſiderable action upon copper, and even has a greater affinity with it than with any other metal excepting iron; hence copper may be ſeparated from almoſt all metals by means of ſulphur, which alſo renders it much more fuſible. Copper is formed into a mineral or pyritous ſtate by union with ſulphur; and if this compound be expoſed to fire, ſo that the ſulphur ſhall be burnt, its acid will act upon the copper, and reduce it to blue vitriol.

Copper may be eaſily united with all metals and ſemi-metals, and with them forms allays; of which *ſee* the detail at the articles ALLAY, BRONZE, TOMBAÇ, *and* SIMILOR.

As this metal is combuſtible, it may be ſeparated from the perfect metals by calcination, which is accelerated by means of lead, as in refining; or by nitre, which generally much accelerates the calcination of all combuſtible bodies; ſo that by repeated projections of nitre upon melted gold and ſilver allayed with copper, the nitre burns the phlogiſton of the copper, and reduces this metal into a ſcoria which floats upon its ſurface: but the nitre muſt be added gradually, and but a little at a time, particularly if much copper be in the allay, becauſe the detonation which it occaſions is ſufficient to diſſipate ſome of the perfect metals. *See* NITRE.

The affinities of copper, according to Mr. Geoffroy, are mercury and lapis calaminaris, or rather zinc; and according to Mr. Gellert, gold and ſilver. *(c)*

COPPER (WHITE). White copper is an allay of copper, zinc, and arſenic, in certain proportions, and is white as ſilver. The preciſe proportions cannot be eaſily determined, and the allay cannot without difficulty be made, becauſe of the volatility of the two ſemi-metals. Neverthele ſs, a very beautiful and ſilver-like white copper is made by ſome artiſts, who carefully conceal their method of preparation.

As this allay is not much uſed, from its very noxious quality, chemiſts have not conſidered it; otherwiſe any of them who knew the management of metals might probably diſcover it.

(c) Wallerius ſays, that if a mixture of calx of copper and ſal ammoniac be expoſed during a certain time to air, from that maſs, by diſtillation with ſoap, mercury may be obtained; whence he infers, that either mercury is a component principle of copper, or that at leaſt ſome part of the copper is convertible into it.

The medicinal virtues of copper are treated of under the article BRASS.

CORAL. (*d*)

CORK. (*e*)

CORK (FOSSIL). (*f*)

CREAM. This name is applicable to all ſubſtances which ſeparate from a liquor, and collect upon its ſurface; but it is particularly given to the following ſubſtances:

CREAM *of* LIME. The cream of lime is that moſt attenuated part of quicklime, and moſt approaching to a ſaline ſtate, which is diſſolved by water with which quicklime is ſlaked, or even in which ſlaked lime is boiled. This matter ſeparates from lime-water by cryſtallization during the evaporation of the water; and as water only evaporates at its ſurface, this earthy cryſtallization is alſo formed there. It forms a ſemi-tranſparent pellicle, which becomes thicker and thicker till it ſeparates into pieces, and falls to the bottom by its weight in form of ſcales. The cream of lime has the ſame properties as ſlaked lime has. *See* QUICK-LIME. (*g*)

(*d*) CORAL *and* CORALLINE are ſhells of marine animals of the polypus kind, and poſſeſs the ſame chemical properties as the freſh ſhells of oyſters and other ſhell-fiſh, that is, they are calcareous earths impregnated with ſome animal principles. *See* EARTHS (CALCAREOUS). From ſixteen ounces of coral, Neuman obtained by diſtillation ſix ſcruples of a volatile, alkaline, oily ſpirit, two or three grains of empyreumatic oil, and a reſiduum containing five ſcruples and a half of fixed ſalt, probably ſea-ſalt. The quantities of theſe component parts were found to vary according to the freſhneſs of the coral analiſed.

(*e*) CORK is the bark of a tree of the oak kind, which grows in the ſouthern parts of Europe. From an ounce of cork Neuman extracted, by boiling in water, two ſcruples; and from the ſame quantity he obtained, by digeſtion in ſpirit of wine, two ſcruples and two grains.

(*f*) CORK (FOSSIL), *Suber montanum*. This name is given to a ſtone which is a ſpecies of amianthus, conſiſting of flexible fibres looſely interwoven, and ſomewhat reſembling vegetable cork. This is the lighteſt of all ſtones. By fire it is fuſible, and forms a black glaſs. It poſſeſſes the general properties of amianthus. *See* AMIANTHUS.

(*g*) Cream of lime is very different from ſlaked quick-lime. The latter ſubſtance is calcareous earth deprived of its gas, or fixable air, and combined with water: it is cauſtic, ſoluble in water, and poſſeſſes all the properties of quick-lime, from which it differs only in containing a quantity of water. Cream of lime is

CREAM *of* MILK. This is the moſt oily part of milk; which being naturally only mixed, and not diſſolved in milk, and being ſpecifically lighter than the other parts, ſeparates from them by reſt, and collects on the ſurface of the milk, from which it is generally ſkimmed to complete the diſengagement of the oily from the caſeous and ſerous parts, that is, to make it into *butter*. *See* BUTTER *and* MILK.

Cream of milk, which is generally called ſimply *cream*, is not only an agreeable aliment when recent, but is alſo uſeful in medicine as a lenient, when applied to tetters and eriſipelas accompanied with pain, and proceeding from an acrid humor.

CREAM *of* TARTAR. Cream of tartar is, properly ſpeaking, that part of the concrete acid of tartar which cryſtallizes firſt, forming a pellicle on the ſurface of water in which tartar has been boiled, with intention to purify it, and to ſeparate from it its moſt ſaline part. Thus this ſubſtance called *cream*, from its manner of formation, does not eſſentially differ from the cryſtals of tartar which are formed in the liquor; and theſe cryſtals are accordingly, as well as the ſaline pellicle, generally called cream of tartar, theſe two matters being confounded together by one name, from which no inconvenience reſults. *See* TARTAR.

CRIMSON. (*b*)

CROCUS. This Latin word, ſignifying *ſaffron*, has been applied as a name to earths of certain metals, which in color ſomewhat reſemble ſaffron: ſuch particularly are the earths of iron and of copper, each of which is therefore called *crocus*, the firſt being the *crocus of mars* or *of iron*, and the ſecond *the crocus of copper*: but the word *ſaffron* is more commonly employed, and particularly applied to the earth of iron. *See* SAFFRON.

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is calcareous earth, which having been deprived of its gas by calcination, and diſſolved by water, is, by expoſure to air, again combined with gas; by which it is rendered mild, cryſtallizable, unſoluble in water, and reſtored to its original ſtate before calcination. *See* GAS.

(*b*) CRIMSON. A crimſon color may be given to ſilks and woollen cloths by cochineal. *See* COCHINEAL. A leſs durable crimſon may be given by Brazil wood. For the color called by dyers demi crimſon, the root of madder is mixed with cochineal. *See* RED *and* DYING.

CRUCIBLE. (*i*)

CRYSTAL. Cryſtal, called alſo *rock-cryſtal*, or *natural cryſtal*, is a hard, tranſparent ſtone, of the figure of a priſm with ſix faces, which is terminated at each of its extremities by hexagonal pyramids.

The moſt beautiful rock-cryſtal is that which is perfectly clear, white, and tranſparent. It is frequently cut; and luſtres, vaſes, and toys are made of it, as of other beautiful ſtones. Rock-cryſtals, like the precious ſtones, are of all colors; and they receive their color, as the precious ſtones do, from metallic and phlogiſtic ſubſtances. Some of them are brown, and almoſt black; theſe may be rendered white and tranſparent, by making them red-hot, which muſt be done very gently and gradually, to prevent their cracking, which they are very apt to do as well as other vitrifiable ſtones. *See* EARTH (VITRIFIABLE. (*k*)

(*i*) *See* POTTERY.

(*k*) *Cryſtal*, *rock-cryſtal*, or *quartz-cryſtal*, is a tranſparent ſtone of the claſs of earths called by ſome ſiliceous, and by others vitrifiable. Its form is that of an hexagonal priſm, one or both ends of which are terminated by hexagonal pyramids. Some of them conſiſt of theſe two pyramids joined together at their baſes, without any priſm interpoſed. Cryſtal is frequently found adhering to quartz; and, according to Cronſtedt, it is nothing but quartz, which he affirms always aſſumes this hexagonal form, when its accretion or cryſtallization has not been interrupted. Cryſtals are either colorleſs, or colored. Thoſe which are red are called *falſe rubies*; the violet colored, *falſe amethyſts*, or, according to Cronſtedt, the *true amethyſts*; the yellowiſh-red, *falſe hyacinths*; the blue, *falſe ſaphirs*; yellow, *falſe topazes*; the greeniſh-yellow, *falſe chryſolites*; the green, *falſe emeralds*; the ſea-green, *falſe beryls*. Some cryſtals are duſky, brown, or blackiſh, but ſtill tranſparent. Cryſtals poſſeſs the general properties of the earths called vitrifiable. *See* EARTHS (VITRIFIABLE). Colorleſs cryſtals reſiſt the moſt violent and long continued fires. *See Mr.* D'ARCET *upon Vitrification*, in the *Memoirs* of the *Academy of Sciences*, for 1776. Moſt of the colored cryſtals are fuſible by violent fire. They probably receive this fuſibility, as well as their color, from metallic ſubſtances. Colorleſs cryſtals may be tinged with various colors, ſo as to imitate precious ſtones. For this purpoſe, Neri, in his *Art of making Glaſs*, directs that pieces of clear cryſtal ſhould be laid upon a mixture of four parts of orpiment, four parts of crude antimony, and one part of ſal ammoniac, placed in a crucible, to which another crucible inverted is

CRYSTAL (FACTITIOUS). The word cryſtal has been applied to glaſſes produced by art, which from their tranſparency and whiteneſs imitate rock-cryſtal. In fact, ſome are made as beautiful as the fineſt rock-cryſtals, but not nearly ſo hard. The heat of ordinary vitrification ſeems incapable of producing glaſs as hard as rock-cryſtal; nor do our crucibles ſeem capable of ſuſtaining the requiſite heat, if it could be raiſed. *See the method of making cryſtal-glaſs at the words* GLASS *and* VITRIFICATION.

CRYSTAL (MINERAL). Mineral cryſtal, called alſo *Salt of Prunella*, is melted nitre detonated with a little ſulphur, and caſt into form of tablets.

Nitre is one of the neutral ſalts which contains the leaſt water in its cryſtallization, or which loſes the leaſt water by a true fuſion, and is alſo one of the moſt fuſible ſalts.

To make mineral cryſtal, very pure nitre muſt be put into a clean crucible, and quickly fuſed, taking care that no aſhes or coal fall in. When the nitre is fuſed, it is to be detonated with ſulphur, in the proportion of a dram of the latter to a pound of the former. It is then to be poured

well luted: the crucibles are to be placed in a furnace, and ſurrounded with charcoal: after heat has been gradually applied till the crucibles become red, and the fire extinguiſhed, the upper pieces of cryſtal will have acquired a fine golden color, reſembling opals, and variegated with beautiful ſpots: the lower pieces of cryſtal will have acquired a fine color, reſembling that of the ſkins of vipers. He gives another proceſs, in which he directs the cementing mixture to be compoſed of two parts of yellow orpiment, two parts of white arſenic, one part of crude antimony, and one part of ſal ammoniac. He directs alſo, that no bellows or ſtrong current of air ſhould be applied to the fire, by which he ſays, that the cryſtals are apt to be cracked, probably by making the heat too intenſe, and that the crucibles ſhould not be opened till they have been gradually cooled. Cryſtals thus treated reſemble rubies, opals, agates, turquois, marbles, chryſolites. Mr. Pott ſays, that he found the color of ſome cryſtals much improved by repeating the operation. Baptiſta Porta directs, that cryſtals ſhould be colored by keeping them immerſed during four or five hours in a melted mixture of ſulphur, crude antimony, orpiment, arſenic, and tutty. In theſe operations, the cryſtals ſeem to imbibe ſome of the vapors of the metallic ſubſtances. The chief difficulties ſeem to be to prevent the cracks to which the cryſtals are very ſubject by this treatment, and to procure a ſufficient penetration. Probably both theſe purpoſes might be effected by a very ſtrict attention to the gradual application, and to the maintenance of a due degree of heat.

into a copper, or rather a ſilver baſon, in which it is to be agitated while yet fluid, that it may fix in form of cakes or tablets.

No other effect is produced upon the nitre by the ſmall quantity of ſulphur with which it is detonated, than to introduce into it a proportionable quantity of vitriolated tartar, called *Sal Polychreſt of Glaſſer.* In all other reſpects, chemical and medicinal, mineral cryſtal is nitre, and may be given like this, from four grains to ten or twelve, in a quart of proper drink. It is cooling, ſedative, aperitive and diuretic. This preparation then ſeems uſeleſs, ſince the ſame intentions may be better accompliſhed by well purified nitre. *See* NITRE.

CRYSTALLIZATION. This word is ſometimes employed to ſignify ſubſtances which are cryſtallized, or whoſe parts are ſo arranged that they form regular figures. In this ſenſe, we ſay *ſtony cryſtallizations*, *pyritous cryſtallizations*, &c.

CRYSTALLIZATION *of* SALTS *and of other Subſtances.* If the word cryſtallization were to be confined to its moſt proper ſenſe, as it ſeems to have been formerly, it could only be applied to operations by which certain ſubſtances are diſpoſed to paſs from a fluid to a ſolid ſtate by the union of their parts, which ſo arrange themſelves that they form tranſparent and regularly figured maſſes, like native cryſtal; from which reſemblance the word cryſtallization has evidently been taken.

But modern chemiſts and naturaliſts have much extended this expreſſion, and it now ſignifies a regular arrangement of the parts of any body which is capable of it, whether the maſſes ſo arranged be tranſparent or not. Thus opake ſtones, pyrites, and minerals, when regularly formed, are ſaid to be cryſtallized, as well as tranſparent ſtones and ſalts.

The opacity and tranſparency of ſubſtances are juſtly diſregarded in conſidering whether they be cryſtallized or not; for theſe qualities are perfectly indifferent to the regular arrangement of the integrant parts of ſubſtances, which is the eſſential object of cryſtallization.

This being eſtabliſhed, cryſtallization ought to be defined an operation by which the integrant parts of a body, ſeparated from each other by the interpoſition of a fluid, are diſpoſed to unite again and to form ſolid, regular, and uniform maſſes.

To underſtand as much as we can of the mechaniſm of cryſtallization, we muſt remark,

1. That the integrant parts of all bodies have a tendency to each other, by which they approach, unite, and adhere together, when not prevented by an obſtacle.

2. That in ſimple, or little-compounded bodies, this tendency of integrant parts is more obvious and ſenſible than in others more compounded: hence the former are much more diſpoſed to cryſtallize.

3. That although we do not know the figure of the primitive integrant molecules of any body, we cannot doubt but that the primitive integrant molecules of every different body have a conſtantly uniform and peculiar figure.

4. That theſe integrant parts cannot have an equal tendency to unite indiſcriminately by any of their ſides, but by ſome preferably to others, excepting all the ſides of an integrant part of a body be equal and ſimilar; and probably the ſides, by which they tend to unite, are thoſe by which they can touch moſt extenſively and immediately. The moſt general phenomena of cryſtallization may be conceived in the following manner.

Let a body be ſuppoſed to have its integrant parts ſeparated from each other by ſome fluid. If a part of this fluid be taken away, theſe integrant parts will approach together; and as the quantity of intervening fluid diminiſhes, they will at laſt touch and unite. They may alſo unite, when they come ſo near to each other that their mutual tendency ſhall be capable to overcome the diſtance betwixt them. If, beſides, they have time and liberty to unite with each other by the ſides moſt diſpoſed to this union, they will form maſſes of a figure conſtantly uniform and ſimilar. For the ſame reaſon, when the interpoſed fluid is haſtily taken away, ſo that the integrant parts ſhall be approximated, and be brought into contact before they have taken the poſition of their natural tendency, then they will join confuſedly by ſuch ſides as chance preſents to them; they will in ſuch circumſtances form ſolid maſſes, whoſe figures will not be determinate, but irregular and various.

In every cryſtallization all that we have deſcribed may be obſerved.

If cryſtallization be taken in the general ſenſe we have given to it, ice is a true cryſtallization. Water, for inſtance, is to be conſidered as a body whoſe integrant parts are ſeparated from each other by the interpoſition of the matter of fire. Melted metals are alſo to be conſidered in the ſame manner. The fluidity of theſe bodies is to be attributed to this matter of fire, with which theſe bodies are penetrated. When therefore theſe liquefied bodies cool, which can only be by taking away this igneous matter that penetrates them; if the approximation of the integrant parts, which is a neceſſary conſequence of this cooling, be made ſo ſlowly that they ſhall have time and liberty to unite by the ſides moſt diſpoſed to this union, they will always form maſſes of a conſtant and ſimilar figure.

Thus when water freezes ſlowly, and is not agitated by any motion which can diſturb the order in which the integrant parts tend to unite, it forms regular cryſtals of ice, and always of the ſame form.

Theſe cryſtals which may be called cryſtals of water, are long, needle-like maſſes, flattened on one ſide, joined together in ſuch a manner that the ſmaller are inſerted into the ſides of the greater; and thus theſe compound cryſtals have the appearance of feathers, or of leaves of trees.

The moſt remarkable circumſtance attending this cryſtallization is, that the angle formed by the inſertion of the ſmaller needles into the ſides of the larger ones is always of the ſame width, that is, ſixty degrees. However, it is ſometimes double, that is, 120 degrees; but it is conſtantly one of theſe two angles, and it is to be remembered that theſe angles are complements to each other, that is, they are together equal to two right angles. We are obliged to Mr. Mairan for theſe fine obſervations, which he has given at full length in an excellent diſſertation on ice.

Metal, ſulphur, and ſeveral other bodies not much compounded, which fix and become ſolid after fuſion, aſſume always a regular arrangement whenever they are ſlowly enough cooled for that purpoſe. The ſtar of the regulus of antimony has been long obſerved with wonder. Alchemiſts, who ſaw wonders in all their operations, conſidered this ſtar as ſomething myſterious and ſignificant; but the wonder ceaſed when the cauſe of it was inveſtigated by ſo good a philoſopher as Mr. Reaumur, and diſcovered to be the tendency which the integrant parts of the regulus of antimony have to arrange themſelves in an uniform manner; for this arrangement always happens, when the regulus of antimony has been well fuſed, and ſlowly cooled. Mr. Macquer and Mr. Beaumé having fuſed ſilver with great heat, and afterwards very ſlowly cooled it, obſerved that this metal alſo arranged itſelf in a regular manner. Mr. Beaumé obſerved the ſame effect upon applying to all the other metals and ſemi-metals the ſame treatment. Every metallic ſubſtance was found to have its peculiar form, which Mr. Beaumé propoſes to determine.

What we have ſaid concerning bodies, which being fuſed by fire, are cryſtallized when they become ſolid by cold, may alſo be applied to all thoſe whoſe integrant parts ſwim ſeparately from each other in a fluid ſuch as water. Thus all kinds of earths, and of metallic and mineral matters, which are found in that ſtate, may be cryſtallized by taking away ſome of the watery fluid which ſeparates their integrant parts. A ſlow evaporation of the water which contains theſe ſubſtances allows their parts to approximate and to unite together by the moſt ſuitable ſides, and to form maſſes of a determinate and conſtant figure.

In this manner are formed the cryſtallizations of precious ſtones, of rock cryſtal, of ſpars, of certain ſtalactites, and of all ſtony bodies found ſo frequently well cryſtallized. The regular forms of moſt pyrites, of many ores and metallic minerals, and even of ſome pure metals, ſuch as gold, ſilver, copper, which are found regularly arranged and ramified, ought to be attributed to the ſame mechaniſm, that is, to the ſlow ſeparation of their integrant parts from the water in which they are ſuſpended.

But of all the ſubſtances thus ſuſceptible of cryſtallizing by their ſeparation from water, ſalts are moſt diſpoſed to it, and afford the beſt examples of cryſtallization; becauſe all ſaline ſubſtances being eſſentially ſoluble in water, are liquefied by this fluid in a much greater quantity than the bodies we have mentioned, which, properly ſpeaking, are only miſcible with water.

This property which ſalts have of being ſoluble by water muſt depend on a certain affinity or adheſion of their integrant parts to thoſe of water; and from this adheſion we can deduce the phenomena peculiar to the cryſtallization of ſalts, and the differences obſervable betwixt the cryſtallization of theſe, and that of other ſubſtances to which water has not the ſame affinity. We ſhall relate what is moſt neceſſary to be known concerning the cryſtallization of ſalts, an object of great importance in chemiſtry.

The cryſtallization of a ſalt diſſolved in water may be procured, as evidently appears from what we have ſaid, by taking away the diſſolving water: and as moſt ſalts are leſs volatile than water, and may even be conſidered comparatively as fixed ſubſtances, this ſubſtraction may be commodiouſly made by the evaporation of a ſufficient quantity of water. The parts of the ſalt, being ſufficiently approximated by this evaporation, will unite together and form cryſtals, as we have already explained concerning other ſubſtances. But as the ſaline parts adhere to thoſe of the water, this circumſtance occaſions an eſſential difference in the cryſtallization; which is, that the ſalt when cryſtallizing, does not ſeparate itſelf from all the water with which it was united in ſolution, but retains ſome part of it with ſome force; and this portion of water adhering to, and even combined with the parts of ſalt, makes with it one whole or entire body; whence ſaline cryſtals are compounded of cryſtallized ſalt, and of water which makes part of theſe cryſtals. This water is called by chemiſts the *water of cryſtallization.*

As this water of cryſtallization is ſuperabundant to the eſſence of the cryſtallized ſalt, it may be taken from it by evaporation with a certain degree of heat, without any change produced upon the eſſential properties of the ſalt; ſo that it may be again diſſolved and cryſtallized as at firſt. But we muſt obſerve, that the water of cryſtallization cannot be taken from any ſalt without deſtroying the form, or at leaſt the conſiſtence, or the tranſparency of the cryſtals; and when the ſalt is to be re-diſſolved and re-cryſtallized, it retains in this ſecond cryſtallization the ſame quantity of water preciſely as it had in the firſt.

Hence we ought to conclude that this water of cryſtallization is not eſſential to a ſalt, as a ſalt, but that it is eſſential to a ſalt as being cryſtallized; ſince to it the ſaline cryſtals owe their form, tranſparency, and even the coheſion of their parts.

The quantity of water of cryſtallization varies much in different ſalts. Some of theſe, as alum, Glauber's ſalt, and martial vitriol, contain about half their weight of water; and others, as nitre and ſea-ſalt, contain but a ſmall quantity. Selenites contains an almoſt inſenſible quantity of water. This difference ſeems to depend on the ſtate of the acid in theſe ſalts; and in general the more firmly an acid is combined with its baſis, the leſs water it retains in cryſtallization.

A very important remark to be made upon this water of cryſtallization, is, that when the cryſtallization is properly managed, this water is perfectly pure, and contains no ſubſtance foreign to the cryſtallized ſalt. To Mr.

Beaumé we owe this diſcovery. By many experiments he was convinced that no neutral ſalt, with a baſis of fixed alkali, retains in its cryſtals either ſuperabundant acid or alkali, or any other matter foreign to the neutral ſalt, although even this ſalt had been cryſtallized in a liquor that was acid, alkaline, or impregnated with any other ſubſtance foreign to the ſalt ; and that if ſometimes theſe heterogeneous ſubſtances are found included in ſaline cryſtals, they have no adheſion to them, ſince they may be ſeparated merely by draining upon brown paper, without any change produced upon the cryſtals of the ſalt ; whereas the water of cryſtallization cannot be taken away without a deſtruction of the cryſtals. The cauſe of this phenomenon will eaſily appear, when we recollect that ſalts retain the water of their cryſtallization by the adheſion of theſe ſalts to water ; and that if a ſalt be diſſolved in water impregnated with acid, alkali, or other ſubſtance foreign or ſuperabundant to the ſalt diſſolved, this ſalt does not adhere either to the ſuperabundant acid, or alkali, nor to the other extraneous ſubſtances, but to the water alone.

Evaporation of water, in which ſalt is diſſolved, is not the only method by which the ſalt can be cryſtallized. Another method which may be uſed with ſucceſs, at leaſt for the cryſtallization of moſt ſalts, is by application of cold to the water ſuſpending the ſalt. The reaſon of this is as follows.

All ſalts are ſoluble in water, but not with equal facility, ſome of them requiring much water, and others very little : moſt of them are more eaſily diſſolved, and in greater quantity, by hot than by cold water ; and others with nearly equal facility, and in equal quantity by both hot and cold water. This being eſtabliſhed, when boiling water, that is, water heated as much as poſſible, ſuſpends in ſolution all that it can diſſolve of thoſe ſalts which are more ſoluble by hot than by cold water, if this water be cooled, the portion of ſalt which was diſſolved merely by the heat of the water, will be collected and cryſtallized as faſt as the water cools. We may alſo obſerve, that when this cooling of the water is very quick, the cryſtals it occaſions are ſmall, irregular, and ill-ſhaped ; and that the more ſlowly the cooling is produced, the larger and better formed the cryſtals are.

What has been hitherto ſaid concerning the regular forms taken by certain liquefied matters during their fixing or becoming ſolid, is entirely applicable to this kind of cryſtallization of ſalts. This cryſtallization is not effected by a ſubſtraction of water but of fire, by which ſubſtraction a condenſation of the ſaline liquor is produced, and conſequently a ſufficient approximation of the parts of the diſſolved ſalt to diſpoſe them to unite, and to form cryſtals; and as in this caſe, the fluidity or the ſolidity of the ſalt is ſolely occaſioned by the preſence or abſence of the matter of fire, theſe ſalts diſſolved by heat, and cryſtallized by cold, may be compared to melted metals, the parts of which are regularly arranged by a ſlow cooling. But with regard to ſalts we muſt obſerve, that as their cryſtallization is performed in a fluid to which they have an adheſion, they retain the ſame quantity of water of cryſtallization, whether the operation was performed by cold or by evaporation.

Hence we may perceive, that evaporation and cooling are the two principal methods of cryſtallizing ſalts. Sometimes it is proper to employ one only of theſe methods, and at other times both together, according to the particular nature of the ſalt to be treated. If it be one of thoſe ſalts which are better cryſtallized by cooling than by evaporation, ſuch as nitre, for inſtance, then the former method ought to be uſed; for nitre cannot be well cryſtallized by evaporation alone, becauſe the water which keeps it diſſolved would be reduced almoſt to nothing before the cryſtallization would begin, and the liquor would be ſo concentrated that the parts of the ſalt would not arrange themſelves properly.

When, therefore, nitre is to be cryſtallized, the water is to be evaporated ſo far only, that when it cools, cryſtals ſhall be formed. This degree of evaporation is known by taking a few drops of the hot liquor, and cooling them quickly; if the evaporation has been ſufficient, ſmall cryſtals may be perceived inſtantly formed. As the evaporation here mentioned does not occaſion the cryſtallization of the nitre, but is only preparatory to it, this evaporation may be either quick or ſlow without inconvenience. The liquor may be made to boil as faſt as poſſible, and the cryſtals of nitre will be no leſs perfect, provided that this liquor when ſufficiently evaporated be ſlowly cooled: when it is perfectly cooled, no more cryſtals will be formed in it. It ought then to be poured off, and again evaporated, when by a ſecond cooling it will furniſh more cryſtals, and this treatment is to be continued to the end.

But if well formed cryſtals are to be obtained of one of thoſe ſalts which are nearly as ſoluble in cold as in boiling water, and which conſequently cannot be cryſtallized by cold, evaporation is the only method to be uſed. Common ſalt is a proper inſtance of this kind.

Water impregnated with common ſalt muſt be evaporated to obtain cryſtals; and when the liquor contains much more water than is neceſſary to the ſolution of the ſalt, the evaporation may be carried on as faſt as poſſible till the cryſtallization is ready to begin. This point is known by a thin, ſaline pellicle, which floats on the ſurface of the liquor, and ſeems as if duſt had fallen upon it. This pellicle is compoſed of the firſt portions of ſalt beginning to cryſtallize. It is always formed at the ſurface; becauſe this ſalt cryſtallizes by evaporation only, and evaporation is only at the ſurface.

Mr. Rouelle, in his Memoir concerning the Cryſtallization of Sea-ſalt, ſays, that he has obſerved, that when the evaporation has been very ſlow, and with a heat not much exceeding that of ſummer, the cryſtals of common ſalt are formed at the bottom and not at the ſurface of the liquor. As this appears quite contrary to the manner in which this ſalt cryſtallizes in all other circumſtances, have we not reaſon to believe, that in this inſenſible evaporation the cryſtals of ſea-ſalt are formed firſt at the ſurface, as in all other evaporations, but that they cannot be perceived from the extreme ſmallneſs of their ſize at firſt; and becauſe the heat is too weak to dry their upper ſurface, and to make them adhere to the air, theſe ſmall cryſtals fall to the bottom without being perceived, and there become larger by the union of other ſmall cryſtals, formed and precipitated in the ſame manner?

If the evaporation when brought to the point of cryſtallization was to be ſtopt, and the liquor to be cooled after it has been filtrated, and put into a bottle to prevent further evaporation from the remaining heat, ſcarcely any cryſtals would be formed in it, but the ſalt would remain diſſolved in the water. If, on the contrary, the evaporation ſhould be haſtily continued, ſalt would indeed be formed in great quantity; but as its parts would not have time to arrange themſelves properly, the cryſtals would be ſmall and ill-formed *. The evaporation therefore ought to be

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* Although cryſtals of ſea-ſalt are generally leſs regular when formed by a haſty than by a ſlow evaporation, this irregularity is, however, leſs ſenſible in this ſalt than in moſt others, and its cryſtals

be continued, but ſlowly: and by this method very beautiful cryſtals will be obtained, partly in cubes, partly in hollow pyramids formed by cubes †.

The rules of cryſtallization moſt ſuited to the nature of each ſalt muſt be obſerved, not merely to obtain well-formed cryſtals; for if their figure was once determined, the regularity of their cryſtallization would be afterwards of no conſequence: but the cryſtallization of ſalts relates to an affair of much more importance, which is their purity.

We have already ſaid, that, when a ſalt is well cryſtallized, the water of its cryſtallization is very pure, and contains none of the heterogeneous matters which happened to be mixed with the ſolution of the ſalt before cryſtallization. This obſervation may be extended to other ſalts which may happen to be diſſolved in the ſame liquor. If then ſeveral ſalts be diſſolved together, we may almoſt always ſeparate them exactly from each other, by cryſtallizing each of them according to their character; for amongſt the almoſt infinite number of ſalts now known, ſcarcely two ſhow preciſely ſimilar phenomena in cryſtallization. We may, from the example of ſeparating nitre and common ſalt, when diſſolved together in the ſame liquor by cryſtallization, ſhow how ſuch ſeparation may be done

cryſtals always tend to a cubic form, or at leaſt appear compoſed of cubes. From this obſervation we have reaſon to believe that the primitive integrant molecules of this ſalt are cubes: hence we may conceive that as all the ſides of this ſalt are equal and ſimilar, from their union regular ſolids ought to reſult, more or leſs approaching to the cubic figure, by whatever ſide they may have been united. *Note of the Author.*

† Although in a moderate evaporation a very large quantity of cryſtals of common ſalt is formed in quadrangular, hollow, and inverted pyramids, the cubic figure is nevertheleſs the primitive and eſſential form of this ſalt; for theſe pyramids are all compoſed evidently of cubes. Beſides, they are only formed accidentally, by the union of ſeveral quadrangular priſms compoſed of cubes, which are ſucceſſively applied to the ſides of a firſt cube; which being formed at the ſurface of the liquor, remains ſuſpended there, by the adheſion of its upper dried ſurface to the air. As this cube is beſides a little ſunk into the liquor by its weight, ſo that the liquor riſes along its ſides, it becomes by that means a very proper foundation for the formation of this pyramid. This mechaniſm is explained at length in Junker's book, and in a Memoir of Mr. Rouelle concerning the cryſtallization of ſea-ſalt, printed in 1745. *Note of the Author.*

in general, even when ſeveral ſalts happen to be ſo confounded. This is certainly one of the fineſt and moſt uſeful problems in chemiſtry.

Let us then ſuppoſe that nitre and ſea-ſalt, diſſolved in the ſame liquor, are to be ſeparated from each other. The method of effecting this will appear evidently from conſidering what we have ſaid concerning cryſtallization; and this method will be found to conſiſt in employing alternately evaporation and cooling. Firſt of all then, the liquor muſt be evaporated. If, during the evaporation, a pellicle appears on the ſurface, and no cryſtals of nitre appear in a ſmall quantity of the liquor when haſtily cooled, then we diſcover that common ſalt is in greater quantity than the nitre. In this caſe the evaporation muſt be continued, and the common ſalt ſeparated as faſt as it is formed, till a ſmall quantity of the liquor, when haſtily cooled, ſhews ſmall needle-like cryſtals of nitre; then the liquor is to be left to cool, that the nitre may have an opportunity of cryſtallizing by cooling; after which the evaporation is to be reſumed that more common ſalt may be ſeparated, and to diſſipate ſo much water, that cryſtals of nitre ſhall again be formed by cooling. Thus theſe ſalts may be alternately cryſtallized, one by cooling, and the other by cryſtallization, till they are entirely ſeparated.

If, in the beginning of the operation, the liquor had, upon trial in ſmall quantity, given cryſtals of nitre by cooling, before any pellicle had appeared upon its ſurface, the common ſalt would then have been known to be in much leſs quantity than the nitre. In this caſe, the nitre would have been cryſtallized firſt, but always by cooling. The quantity of nitre, which exceeds that of common ſalt, having been thus ſeparated, the common ſalt would then begin to cryſtallize in its turn by evaporation.

Several eſſential remarks are to be made upon this ſeparation of ſeveral ſalts from each other by cryſtallization.

Firſt, although the two ſalts, the method of ſeparating which we have given as an example, are the moſt capable of ſuch a ſeparation, becauſe ſea-ſalt is one of the ſalts which are leaſt of all to be cryſtallized by cooling; and on the contrary, nitre is one of thoſe which are beſt cryſtallized by this method; nevertheleſs, after a firſt cryſtallization of theſe two ſalts, ſuch as we have deſcribed, they are not entirely and perfectly ſeparated from each other: the ſea-ſalt contains ſome nitre, and the nitre contains ſome portion of ſea-ſalt; becauſe in cryſtallization one ſalt always takes with it a ſmall portion of another: but when two ſalts are ſo different from each other in this reſpect as theſe two, a perfect ſeparation may be eaſily made by diſſolving each of them ſeparately in more water, and by proceeding to their cryſtallization by the ſame method. As a new ſeparation is made by each cryſtallization, they may be obtained at laſt perfectly pure by repeating ſufficiently this management.

The ſecond remark to be made on the ſeparation of ſalts by cryſtallization is, that this ſeparation is ſo much more difficult and long, in proportion as the ſalts to be ſeparated are more ſimilar to each other in their manners of cryſtallization. For inſtance, if two ſalts are only capable of cryſtallizing by evaporation, as ſea-ſalt and vitriolated tartar, or by cooling, as nitre and Glauber's ſalt, they cannot be ever obtained quite pure and ſeparated from each other by any management: nevertheleſs, even in this caſe they may be in great meaſure ſeparated; firſt, becauſe the preciſe degree of evaporation, or of cold, which is neceſſary for the cryſtallizing of one ſalt, is generally ſomewhat different from that which is requiſite for the cryſtallization of another ſalt; ſecondly, becauſe although they ſhould reſemble each other much in this reſpect, ſome differences, which muſt be obſervable in the ſize and form of their cryſtals when well formed, will furniſh means of making at leaſt an imperfect ſeparation, which may be made more perfect by repeating this management.

But the ſeparation of ſome ſalts is attended with ſingular and even inſuperable difficulties. Such are the ſalts which have ſome action upon each other, and the parts of which have ſome adheſive power together. This action of neutral ſalts upon each other has been very little obſerved: it is, nevertheleſs, very ſenſible in ſome of them; ſuch are ſal ammoniac and corroſive ſublimate, which not only act as intermediate ſubſtances to each other, by which they can be diſſolved in greater quantities in water and in ſpirit of wine than they can ſingly, but which being diſſolved together in the ſame menſtruum, cannot be again cryſtallized ſeparately by any method; as Mr. Macquer has ſhewn in his Memoir concerning Mr. Garay's Tincture of Mercury, printed in the Collection of the Academy for the year 1755.

Some ſalts have ſo great affinity with water, and are ſo ſoluble by this menſtruum, that they can ſcarcely be cryſtallized. The ſolution of theſe ſalts requires to be evaporated almoſt to dryneſs, or to a thick conſiſtence, and then by cooling they generally form needle-like cryſtals applied longitudinally or tranſverſely to each other. When they are expoſed to the air, they attract humidity, and reſolve into a liquid ſtate. Mr. Rouelle was the firſt who deſcribed, in his Memoir concerning Salts in the year 1744, the cryſtallization of deliqueſcent ſalts, ſuch as marine ſalt and nitre with baſes of calcareous earth, of copper, and of iron, terra foliata tartari, and the ſalts formed by the union of the acids of vinegar and of tartar with iron and with copper.

All theſe ſo difficultly cryſtallizable ſalts may be eaſily ſeparated from ſalts which may be readily cryſtallized, with which they happen to be mixed; becauſe the former ſalts in the evaporations and coolings are always the laſt to cryſtallize.

Two of theſe ſalts, namely nitre and marine ſalt, with baſes of calcareous earth, are found mixed with nitre and marine ſalt with baſes of fixed alkali; both of them in the lixiviums of the manufacturers of nitre, and the latter in almoſt all the waters in which common ſalt is found to be naturally diſſolved: hence, when the proper operations are made to obtain nitre and ſea-ſalt, after all the evaporations and cryſtallizations, a very heavy ſaline liquor remains from which no cryſtals can be procured, called the *mother-water*. Theſe mother-waters of nitre and of common ſalt are, then, nothing but theſe ſalts with earthy baſes almoſt pure; and if a cryſtallization of them were required, the method deſcribed by Mr. Rouelle in the quoted Memoir ought to be practiſed. But this is not a matter worthy the attention of the manufacturers, to whom the perfect purification of nitre and of ſea-ſalt, from an adhering portion of the ſalts with earthy baſis, is of much more importance, as we ſhall ſee when we ſhall treat of theſe ſalts.

Chemiſts have given much attention to this ſubject, the cryſtallization of ſalts; and particularly Mr. Rouelle has made many intereſting reſearches concerning it, which may be ſeen in his Memoir of 1744. But nevertheleſs, much remains yet to be done. The true form of all cryſtallizable ſalts, and the beſt methods of cryſtallizing them, are not yet determined; which will not appear ſurprizing to thoſe who underſtand this ſubject, and who know that one and the ſame ſalt, although conſtantly tending to the ſame form, is nevertheleſs capable of diſguiſing itſelf in many ways, and of taking many different forms, according to the circumſtances during cryſtallization. The quickneſs or ſlowneſs of evaporation, the quantity of water evaporated, the more or leſs haſty cooling, and the different degrees of cold applied, the ſtate of the air and of the liquor with reſpect to reſt or motion, even the form and matter of the veſſel in which a ſalt is cryſtallized, are ſo many cauſes, which, acting ſucceſſively or together in many different ways, are capable of producing numberleſs varieties in the cryſtallization.

Of all the cauſes which we have mentioned, capable of varying cryſtallizations, the nature of the veſſel employed ſeems to deſerve leaſt our attention; yet this may produce ſome change from the greater or leſs adheſion which the ſalt may have to the ſeveral matters of which theſe veſſels are made. For inſtance, we can only attribute to the adheſion of ſalts to the ſides of the veſſels employed the property which moſt of them have to branch out in various manners, and to creep along the ſides of theſe veſſels, particularly when the cryſtallization is very ſlowly performed, ſo conderably that they frequently go even on the outſide of the veſſels. Mr. Beaumé has prevented this phenomenon by hindering the adheſion of the ſalts to the ſides of the veſſels, by rubbing theſe ſides with ſome oil.

From what has been ſaid concerning the action of neutral ſalts upon each other, we may conceive, that when ſuch ſalts happen to be mixed together, they muſt produce conſiderable differences in cryſtallizing.

Many other important obſervations might be made on the cryſtallization of certain ſalts, but they will be better placed under the articles of the ſeveral ſalts which they concern. We are obliged alſo to leave to the underſtanding and reflection of our readers to draw from what we have ſaid many corollaries, the detail of which would be too long. We ſhall only mention a manner of cryſtallizing ſalts which is different from the methods by evaporation and by cooling, but which conſiſts alſo in taking away from the ſalt a portion of water which keeps it diſſolved. This method of cryſtallization is well affected by adding to a ſolution of a ſalt a ſufficient quantity of a ſubſtance which has no action upon that ſalt, but which has greater affinity than the ſalt has with the water which keeps it diſſolved. Spirit of wine, for inſtance, has theſe properties with regard to many ſalts. Thus by adding a ſufficient quantity of rectified ſpirit of wine to a ſtrong ſolution of Glauber's ſalt, of vitriolated tartar, or of ſea-ſalt, this ſpirit of wine ſeizing the water neceſſary for the ſolution of the ſalts, obliges them to cryſtallize immediately: but as this cryſtallization is very haſtily made, and almoſt inſtantaneouſly, the cryſtals are always very ſmall and ill-formed. In this reſpect they reſemble the cryſtals of ſalts produced from a liquor which contained too little water to keep them diſſolved. This happens, for inſtance, when a ſtrong ſolution of alkaline ſalt is combined with concentrated vitriolic acid, to form vitriolated tartar; for this ſalt, which requires much water to keep it diſſolved, does not find enough in the liquor, and appears immediately in form of very ſmall cryſtals like ſand. The ſame thing may be ſaid of vitriols of ſilver and of mercury, of luna cornea, and of other metallic ſalts of this kind produced by adding vitriolic or marine acids to the white metals diſſolved in nitrous acid. Theſe ſalts appear immediately as precipitates, whenever they do not find water enough in the liquors to diſſolve them; and Mr. Rouelle juſtly obſerves, in his Memoir, that they are not precipitates, but true ſalts, which not finding water ſufficient for their ſolution, are obliged to be immediately cryſtallized, but in cryſtals ſo ſmall, from the rapidity of their cryſtallization, that they cannot be known to be cryſtals but with the help of a microſcope.

Notwithſtanding what has been ſaid concerning the irregularity of the cryſtals procured by adding a ſubſtance, which ſeizes the water of the ſolution of ſalts, yet if this addition was managed and gradually made, perhaps it might produce very beautiful and very regular cryſtals. Mr. Beaumé has actually obſerved, that when ſalts were cryſtallized in acid or alkaline liquors according to their nature, their cryſtals were infinitely larger and more regular than they would have been without this circumſtance. *Vegetable ſalt*, for inſtance, and *ſalt of Saignette*, require to be cryſtallized in an alkaline liquor; and *ſedative ſalt* requires an acid liquor, when it is obtained from borax by the intervention of an acid, if we deſire to have fine cryſtals of theſe ſalts. The cauſe of this muſt be, that acids or alkalis, having in general more affinity with water than neutral ſalts have, diminiſh the adheſion of theſe neutral ſalts with the water of the ſolution; for a too great adheſion of a ſalt to water may evidently be a great impediment to its cryſtallization. *See the words* SALT, SALTS (NEUTRAL), *and the ſeveral ſorts of neutral ſalts under their reſpective names.*

CRYSTALS. All neutral ſalts with metallic baſes ſuſceptible of cryſtallization are commonly called by chemiſts *Cryſtals*, when they are actually cryſtallized; and the name of the metal contained in the ſalt is added to diſtinguiſh it. Thus we ſay, *cryſtals of gold*, *of ſilver*, *of copper*, *of lead*, &c. But as theſe names do not indicate the acid contained in each ſalt, they ought to be diſuſed. Here we ſhall only mention two of theſe ſalts called cryſtals; becauſe they are almoſt always diſtinguiſhed by that name. Theſe are the *cryſtals of ſilver*, and *cryſtals of verdegriſe*, or *of copper*.

CRYSTALS *of* SILVER, *or* LUNAR CRYSTALS. Cryſtals of ſilver are neutral ſalts with metallic baſes compoſed of nitrous acid ſaturated with ſilver. When very pure ſilver is diſſolved by very pure nitrous acid, if the acid be ſtrong, cryſtals will be formed merely by the cooling of the ſolution. Theſe cryſtals are white, flattened like thin ſcales, and not very hard. When the nitrous acid uſed to diſſolve the ſilver is weak, no cryſtals are formed; becauſe the water in the acid is ſufficient to keep the newly formed ſalt diſſolved; but lunar cryſtals may eaſily be obtained from this dilute ſolution by evaporating the ſuperabundant water, and letting the liquor cool.

Very beautiful and white lunar cryſtals may alſo be obtained, although the ſilver employed be allayed with copper or iron: becauſe the ſalts formed by theſe two metals with nitrous acid are deliqueſcent, and are not ſo eaſily cryſtallizable as the ſalt with baſis of ſilver. In this caſe the ſolution ought to be evaporated, if it be neceſſary; and the cryſtals of ſilver will be cryſtallized by cooling, while the copper or iron will remain diſſolved. When the colored liquor is poured off, cryſtals will be found ſufficiently white and almoſt pure; but to purify them perfectly, they ought to be drained, diſſolved again in very pure water, and again cryſtallized: then after they are well drained from the liquor, they will be found perfect and beautiful. This even is a method of ſeparating ſilver from the allay of copper, or of iron; and of obtaining from ſtandard ſilver, or ſilver allayed with copper, as fine and colorleſs a ſolution as if teſted ſilver had been employed.

Lunar cryſtals then are a true *lunar nitre*, or *nitre with baſis of ſilver*; and they accordingly have the property of deflagrating upon burning coals, almoſt as well as nitre, with baſis of fixed alkali. When this experiment is made, the ſilver is found after the detonation incruſted upon the ſurface of the coal, in its metallic ſtate.

Notwithſtanding this property which lunar nitre has of detonating with coals, a property which ſhews a ſtrong adheſion of nitrous acid with ſilver; yet this adheſion is not ſufficiently ſtrong to reſiſt a certain degree of heat; ſo that by calcination or diſtillation theſe two ſubſtances may be disjoined.

Lunar cryſtals may be melted with a very gentle, and leſs than a red heat. They eaſily loſe the water of their cryſtallization, and then congeal into a black maſs, which is generally caſt into moulds, and is called *Lapis infernalis*, or *lunar cauſtic*. *See* CAUSTIC (LUNAR).

This ſalt is very cauſtic, as the effects of the lunar cauſtic ſhew in ſurgery, although it has loſt a part of its acid in the fuſion which it receives. This corroſive quality of lunar cryſtals ſeems to render it unfit for internal uſe as a medicine; yet ſome phyſicians preſcribe it as a powerful evacuant of water. Boyle, though not a phyſician, but aſſiſted by ſome perſons of the faculty, propoſes a method of rendering theſe cryſtals of ſilver milder, and boaſts much of them as a remedy. His method conſiſts in adding to a ſolution of them in water another ſolution of an equal quantity of nitre, and evaporating the whole to dryneſs and whiteneſs, with a very gentle fire, by which a portion of the ſpirit of nitre is intended to be taken away without fuſing the ſaline maſs; after which, this ſaline powder is to be made into pills, by forming it into a paſte with ſome bread and water.

Little ſkill in chemiſtry is requiſite to ſhew, that nitre thus mixed with lunar cryſtals, being incapable of acting upon it, cannot render it milder, but muſt leave it unchanged.

Secondly, by the manner of drying this mixture of lunar cryſtals and nitre, leſs of the cauſticity of theſe cryſtals is deſtroyed than by forming them into lunar cauſtic, in which operation they ſuſtain a heat ſufficient to fuſe and to blacken them, and conſequently loſe more of their acid. After theſe conſiderations, we cannot believe that this remedy of Mr. Boyle is ſo mild and innocent as it has been repreſented. This is certain, that, notwithſtanding the praiſes given it by this philoſopher, its uſe has not yet been eſtabliſhed in medicine.

Lunar cryſtals are called by Lemeri *vitriol of ſilver*; but as they contain no vitriolic acid, this name does not ſuit them, and ought only to be given to the ſalt formed by the union of vitriolic acid with ſilver. *See* SILVER.

CRYSTALS *of* COPPER, *or of* VENUS. By theſe names is meant a ſalt formed by the union of the acid of vinegar with copper.

This combination may be made by diſſolving directly copper in good diſtilled vinegar; but it is made much more commodiouſly, and more expeditiouſly, when the copper employed has been previouſly formed into verdegriſe; becauſe the copper in the verdegriſe is already divided and penetrated by a certain quantity of acid of wine: verdegriſe therefore is always uſed for the preparation of cryſtals of copper.

This operation is very ſimple. It conſiſts in diſſolving verdegriſe in good diſtilled vinegar till this acid be ſaturated. For this purpoſe a matraſs is to be uſed, and to be ſet in a ſand-bath with a gentle heat. When the vinegar diſſolves the verdegriſe, it takes a fine greeniſh-blue color. Some chemiſts call it alſo Tincture of Venus. When it ceaſes to act on the verdegriſe, it is to be decanted, evaporated, and cryſtallized. The beautiful greeniſh-blue cryſtals formed are cryſtals of copper. When this ſalt is expoſed to a dry air, it loſes eaſily the water of its cryſtallization, and its ſurface is reduced to a lighter-colored ſea-green powder.

The acid of vinegar does not ſtrongly adhere to the copper in this combination. It may be entirely ſeparated from it by diſtillation; and as it had loſt moſt of its ſuperabundant water when it united with the copper, it may by this method be obtained in its greateſt concentration. It is called *radical vinegar*, and improperly *ſpirit of Venus. See theſe words.*

The principal intention of chemiſts in making cryſtals of Venus is to obtain radical vinegar. But this preparation is alſo uſed by painters; for which reaſon large quantities of it are manufactured, and it is generally ſold under the name of *diſtilled verdegriſe*; probably becauſe diſtilled vinegar is employed in its compoſition. *See* COPPER *and* VINEGAR.

CUCURBIT. A cucurbit is a chemical veſſel employed in diſtillation, when covered with its capital or head. Its name comes from its lengthened ſhape, by which it reſembles a gourd: ſome cucurbits, however, are ſhallow and wide-mouthed. Cucurbits are made of copper, tin, glaſs, and ſtone-ware, according to the nature of the ſubſtances to be diſtilled. A cucurbit provided with its capital conſtitutes the veſſel for diſtillation called *Alembic. See this word, and* PLATE I.

CUPEL. A cupel is a wide-mouthed earthen veſſel, like a flat cup, from which reſemblance it has been named.

The uſe of cupels is to contain gold and ſilver mixed with lead in the operations of refining and of aſſay, and to abſorb the litharge and other ſcorified matters formed in theſe operations.

For this reaſon cupels ought to be made of dry, porous earths, capable of reſiſting the action of ſtrong fire, and of fluxes.

The aſhes of wood and of bones are the moſt proper earths for cupels. Theſe aſhes ought to be perfectly burnt and calcined; that is, till they become white, ſo that they contain no more inflammable principle, which might revivify the ſcorified metals, and occaſion an ebullition during the operation. They ought alſo to be well lixiviated, and deprived of all ſaline matter to avoid their fuſion.

To form cupels, aſhes thus prepared ought to be mixed with water into a paſte, to which a proper form is given by means of a mould. Sometimes they are made into a paſte with ſome beer; a ſmall quantity of clay is added, that they may be moulded more conveniently. *Calcining teſts* made of clay are alſo called by ſome artiſts *cupels*; becauſe they have the ſame form as the refining and eſſay cupels. *See* ESSAY *and* PLATE I. *fig.* 10.

CUPELLATION. Cupellation is an operation by which gold and ſilver are refined or eſſayed by ſcorification with lead upon the cupel. *See* REFINING *and* ESSAY.

DAMPS. Theſe are noxious and even fatal exhalations or vapors, which infeſt ſubterranean places, and particularly mines, if the air be not frequently renewed.

The inſtances of fatal accidents cauſed by theſe vapors are too frequent. Moſt of them kill animals ſo ſuddenly that no aſſiſtance can be given.

Although all theſe vapors produce ſimilar effects, and occaſion ſudden and mortal faintings and ſyncopes, yet ſome differences may be obſerved in the properties and modes of acting of theſe vapors in different places. From which we may preſume, that they are not all exactly of the ſame nature.

Some of them are viſible, and appear in form of a fog; ſuch is that which is found in a quarry near to the mineral waters of Pyrmont; and of which Dr. Seip has given a deſcription in the Philoſophical Tranſactions. This vapor has a ſulphureous ſmell, deſtroys inſects, birds, and in general all animals which approach it, with ſymptoms ſimilar to thoſe which animals ſuffer when placed under an exhauſted receiver of an air-pump.

Others, though perfectly inviſible, produce the ſame effects. Such are, ſays the learned tranſlator of Lehman, thoſe which iſſue from a cave in Hungary, ſituated near Ribard, at the foot of Crapack mountains. Theſe vapors are ſo fatal that they kill birds, while in their flight they approach too near to the mouth of the cave.

Amongſt the noxious mineral exhalations we may alſo place thoſe which are found in the mines of Sal-gem in Poland. Theſe frequently appear in form of light flocks, threads, and webs, like thoſe of ſpiders. They are remarkable for their property of ſuddenly catching fire at the lamps of the miners with a terrible noiſe and exploſion. They inſtantly kill thoſe whom they touch. This exploſion is a true ſubterranean thunder. Similar vapors are found in ſome mines of foſſil-coal.

As arſenic is the greateſt poiſon of all mineral ſubſtances, as it is volatile, and abounds in almoſt all mines, many authors have ſuppoſed that damps contained ſomething arſenical. But this opinion is ſo far from being proved, that ſtrong reaſons induce us to believe that they are of a different nature. We are certain, and I know it from my own experience, that a perſon may be a conſiderable time expoſed to a large quantity of vapors of arſenic without ſuffering any of the ſymptoms occaſioned by damps, and even without being much incommoded. Secondly, the effects produced by arſenic taken internally, even in a large quantity, although terrible, and always fatal, are not nearly ſo ſudden as thoſe occaſioned by damps, which inſtantaneouſly kill. Thirdly, no obſervation or experience have aſcertained the arſenical nature of any damps; and it is even demonſtrable, that many of theſe noxious mineral vapors are nothing elſe than volatile ſulphureous acid.

Laſtly, all thoſe which are not evidently volatile ſulphureous acid appear to be pure, or almoſt pure phlogiſton diſengaged from bodies without burning. They occaſion exactly the ſame accidents as exhalations of liver of ſulphur, of burning coals, and of matters undergoing the putrid or ſpirituous fermentations. The great inflammability of theſe vapors, when they are confined, and condenſed to certain degree, ſuch as thoſe of coal-mines, is a demonſtrative proof of this opinion.

By art we may perfectly imitate theſe vapors. We know that when acids diſſolve imperfect metals, they take from them a conſiderable part of their inflammable principle. This principle is almoſt totally diſſipated in vapors during theſe ſolutions; and if the operation be made in a cloſe veſſel, when this is uncorked, and a lighted candle brought near its mouth, the vapor contained inſtantly catches fire, and occaſions an exploſion ſo much more violent as the quantity of vapor was greater. This phenomenon may be chiefly obſerved when iron is diſſolved in vitriolic acid diluted with a certain quantity of water. If after this exploſion the bottle be left open, ſuppoſing the ſolution of the metal to be continuing, and the flame of a candle applied to the mouth of the containing veſſel; the phlogiſton, which is continually diſengaging and forming vapors, but freely, and without condenſation, will continue to burn in ſuch a manner, that a light-bluiſh flame will be ſeen at the mouth of the veſſel, ſuch as the flame of phlogiſton always is when the phlogiſton is not in an oily ſtate.

Although theſe experiments are generally made by means of a ſolution of filings of iron in vitriolic acid, I doubt not that, by employing proper management, ſimilar vapors might be produced from other imperfect metals, eſpecially thoſe which moſt eaſily part with their phlogiſton when diſſolved by acids, as tin, zinc, and regulus of antimony; and I doubt not that if theſe metallic vapors were collected in a ſufficient quantity in a cloſe place, where the air was not renewed, that they would produce the ſame fatal accidents as theſe called damps.

All theſe conſiderations induce us to believe, that moſt of theſe noxious ſubterranean vapors are nothing but phlogiſton diſengaged from certain ſubſtances, and circulating within the earth. It proceeds from bitumens and from ſulphur, which undergo different alterations and decompoſitions.

Almoſt all chemiſts and metallurgiſts agree in believing, that mineral exhalations contribute to the production of metals. This opinion is ſo much more probable, that, as phlogiſton is one of the principles of metals, (if it be true that theſe mineral exhalations are nothing elſe than phlogiſton) and as this principle is then in a ſtate of vapor, and conſequently much divided, perhaps reduced to its ſmalleſt integrant particles, it is then in its moſt favourable ſtate for combination: it is therefore probable, that when theſe exhalations meet earths diſpoſed to receive them, they combine more or leſs intimately with theſe earths, according to their nature. Perhaps this is the chief operation of the grand myſtery of metalliſation. *See* METALS *and* PHLOGISTON. *(l)*

DECAN-

(l) The damps or vapors mentioned in this article are of two kinds, *inflammable* and *uninflammable*. The inflammable kind is probably, as the author believes, ſimilar to the vapors produced by the ſolutions of iron, zinc, tin, and perhaps of other metallic ſubſtances in vitriolic and marine acid . *See* GAS. This vapor is chiefly found in coal mines, and ſometimes in lead mines, as in thoſe of Mendip hills. Like the inflammable vapor of metallic ſolutions, it is lighter than atmoſpherical air, and conſequently floats chiefly near the roofs of mines: miners, therefore, when it is accidentally inflamed, or when they purpoſely ſet fire to it, to deſtroy it, lie flat on the ground, and thus eſcape burning. This inflammable vapor may perhaps be produced by the decompoſition of pyritous matters, with which moſt mines, eſpecially coal mines, abound. In this decompoſition of pyrites expoſed to air and moiſture, the vitriolic acid of the ſulphur attacks and diſſolves the iron, while the inflammable principle of the ſulphur is diſengaged, and forms this vapor.

The *uninflammable vapors* of mines and ſubterranean places are much more noxious than the former. They ſeem to be ſimilar to the uninflammable vapors produced by the combuſtion of inflammable bodies, as of charcoal, and by fermenting and effervefcing ſubſtances. *See* GAS. Like theſe, they are noxious to animals, extinguiſh flame, and are heavier than atmoſpherical air; for they are chiefly placed at the bottom of the pits in which they are found: accordingly, in the cavern near Pyrmont, mentioned in the text, a man may ſtand upright without any other inconvenience than an uncommon heat of his lower extremities, but he cannot without danger keep his head bent down. The ſymptoms attending perſons expoſed to ſuch vapors ſhew ſufficiently that they are not noxious merely by interception of common air, but by ſome quality which almoſt inſtantly affects and deſtroys the powers of animal life. Some perſons digging in a cellar in Paris were found dead, ſtiff as ſtatues, with open eyes, and ſtanding in the poſture of digging. At Chartres, in France, a perſon going down into a cellar into which a baker had been uſed to throw hot embers from his oven, was inſtantly killed; and when his body was opened, his lungs were found ſpotted with black marks; his inteſtines ſwoln, red and inflamed; and the muſcles of his legs, thighs, and arms, ſeemed to be ſeparated from each other and from the adjacent parts. *See Bomare's Dict. d'Hiſtoire Naturelle, at the word* EXHALAISON.

M. Beaumé

DECANTATION. By this word is meant the ſeparating of a clear liquor from a ſediment, by pouring it gently.

DECOCTION. This word is applied to ſignify either the action of boiling a ſubſtance in water, or the water itſelf in which the ſubſtance has been boiled.

Decoction is only applicable to matters containing ſome principles ſoluble in water; ſuch, particularly, are vegetable and animal matters; and this operation is rather uſed for the purpoſes of medicine than of chemiſtry.

It is nevertheleſs very neceſſary to know well the nature and principles of ſubſtances ſubjected to decoction, that it may be properly managed, and that the principles with which the water becomes impregnated may be known.

Theſe principles muſt evidently be ſuch as are not ſufficiently volatile to riſe with the heat of boiling water, if the decoction ſhould be long continued.

Hence it follows, that plants, or other matters containing volatile principles, cannot be proper ſubjects of decoction, when theſe principles are required. In this caſe the matters may be infuſed with water in cloſe veſſels without heat, or with a heat leſs than that of boiling water.

But on the contrary, when it is not intended to preſerve the volatile parts, or when the matters contain none that are volatile, then decoction may be employed. It even becomes neceſſary when the matters to be treated are ſolid, and of a compact and cloſe texture; becauſe then the water could not extract its principles without a boiling heat.

Moſt ſoft animal matters, as fleſh, tendons, ſkins, may be boiled conveniently in water; becauſe they contain no principle volatile with a boiling heat. Water extracts from them nothing but a gelatinous ſubſtance, and ſome oily parts which float on the ſurface of the water.

M. Beaumé gives an account of two perſons that were expoſed to the damp of a cellar in Paris. One of them died. The other was with difficulty brought to life. This perſon related, that the time from his entry into the cellar to that when he loſt his ſenſes did not exceed two minutes: during which time, he neither felt pain nor oppreſſion. At the inſtant when he was loſing his ſenſes, he found himſelf in a moſt pleaſing ſituation; an inexpreſſible delirium, and agreeable reverie took poſſeſſion of his imagination. This agreeable ſenſation at the very gates of the tomb, was quite free from any of the horrors that uſually accompany death. At laſt he loſt all motion and ſenſation, and remained in that ſituation about an hour and a half, till he was found and carried up from the cellar. *Rozier. Obſervations de la phyſique, Jan.* 1774.

Decoction is the only method by which all the gelatinous ſubſtance of the ſolid parts of animals, as bones and horns, can be extracted.

All vegetable matters which are inodorous, and particularly thoſe which are hard, as roots, barks, are generally boiled when an extraction of their principles by water is required.

However, many of theſe ſubſtances ought not to be boiled; thoſe particularly, the principles of which, when extracted by water, ſuffer ſome change by a continued heat. Peruvian bark, for inſtance, which is inodorous, and contains nothing volatile, ſeems capable of being treated without any inconvenience by boiling; nevertheleſs, Mr. Beaumé obſerves, in his Elements of Pharmacy, that the infuſion of this bark made without heat really contains more of its principles than the decoction. The cauſe of this is, that water extracts from bark not only the ſubſtances of which it is naturally a menſtruum, ſuch as the gummy and extractive matters, but alſo a conſiderable quantity of reſinous ſubſtance, which keeps well diſſolved in the water by means of the former matters, till it is expoſed to heat, and then it immediately ſeparates and precipitates.

Many other vegetable matters exhibit the ſame phenomenon; therefore a general rule may be eſtabliſhed, that decoction ought not to be employed but when abſolutely neceſſary, that is, when the ſame principles or the ſame quantities of theſe principles cannot be obtained by an infuſion, and that without heat, if it can be ſo done, conſidering that the proximate principles of vegetables are generally ſo delicate, and ſo ſuſceptible of change and decompoſition, that frequently the moſt gentle heat changes much their nature and properties. *See* EXTRACTS.

DECOMPOSITION *of* BODIES. The chemical decompoſition of bodies conſiſts in the diſunion and ſeparation of their principles and conſtituent parts. *

This decompoſition ought neceſſarily to be diſtinguiſhed from a mere mechanical diviſion, as the following reflections will ſhew.

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* The word *Decompoſition* is uſed by Boyle, Newton, and other Engliſh authors very differently from the definition given in the text. Theſe authors employ this word to ſignify "the compoſition or junction of two or more bodies which were previouſly compounded of other parts." Many *late* Engliſh authors have however adopted the French ſignification of the words, *decompoſition*, and *to decompoſe*.

All bodies in general, or portions of any matter, may be conſidered as compoſed of parts ſeparable from each other.

We cannot, for inſtance, conceive an atom of matter ſo ſmall, but that this atom may be conſidered as diviſible into parts ſtill ſmaller; and this undoubtedly has given the idea of the infinite diviſibility of matter, a ſubject which we do not mean to examine here, becauſe it does not belong to chemiſtry; beſides that, it is like all thoſe in which the conſideration of infinity is concerned, that is, an abſurdity ſeems to be joined with evidence.

As chemiſtry is a ſcience ſolely founded on experience, we ſhall confine ourſelves to what experience teaches concerning the diviſibility of bodies.

But we are certain that bodies may be very ſoon reduced to ſo ſmall parts that we cannot further divide them, from the deficiency of our ſenſes and of our inſtruments.

One thing is very remarkable in this diviſion, called mechanical, becauſe it is performed by cutting or bruiſing inſtruments; that is, that however ſmall the parts be into which it reduces bodies, theſe parts are always entirely of the ſame nature as the body from which theſe parts were taken. Theſe ſmall parts of bodies are called their integrant parts. Thus, for example, the ſmalleſt atoms into which iron, ſalt, reſin, or other ſubſtance, can be mechanically divided, have all the ſame properties, excepting quantity, which the maſs had before the diviſion.

Hence we ought to conclude, that this mechanical diviſion cannot ſeparate bodies but into homogeneous parts, or parts of the ſame nature: and if we had no other method of dividing bodies, the compounds would always remain ſuch as nature offers to us, without cauſing any other change than a diminution of quantity.

The ſame thing would happen, if all natural bodies were equally ſimple or equally compounded. But all chemical experiments ſhew, that in this reſpect there is a very great diverſity.

Some bodies are ſo ſimple that no change can be produced upon them by any effort of art. Theſe are called by chemiſts elements, or primitive principles. But theſe ſimpler bodies, the parts of which are evidently more ſmall and fine than thoſe of bodies leſs ſimple, become, in the hands of chemiſts, inſtruments capable of dividing theſe latter much further than can be done by mechanical inſtruments. Theſe ſimple bodies are capable of dividing molecules, which would be ſtill imperceptible by our ſenſes, although they were much larger than they are when they have undergone this inviſible diviſion.

To illuſtrate this by an example. Let us ſuppoſe a metallic maſs compoſed of mercury and gold, in ſuch proportion that no mercury can be forced out from the maſs by expreſſion, which is a mechanical method. I ſay then, that the mechanical diviſion which could be made of this compound, would only ſeparate it into ſmaller and ſmaller molecules, each of which would be of the ſame nature as the original maſs, that is to ſay, compoſed of an equal proportion of mercury and gold.

If indeed we had inſtruments and ſenſes ſufficiently fine, we might at length come to molecules, each of which would be compoſed of one atom of mercury and gold, which by one diviſion more would be ſeparated into two atoms, one of each of the two metals diſtinctly. Thus we might obtain the mercury and the gold ſeparately, and conſequently effect a decompoſition of the compound ſubſtance ſubjected to this mechanical diviſion; but the impoſſibility of ſuch a diviſion is ſufficiently demonſtrated.

Yet what mechanical inſtruments cannot do, fire, which is one of thoſe ſimple bodies we have mentioned, is capable of performing. The primary parts of this element, much finer than thoſe of gold or of mercury, become in the hands of chemiſts inſtruments inconceivably fine, which effect a ſeparation of mercury from gold, conſequently reduce to its elements or principles the compound which has been ſubjected to their action, and thus analyſe or chemically decompoſe it. *See* ANALYSIS.

DECREPITATION. By decrepitation is meant the quick ſeparation of the parts of a body, occaſioned by a ſtrong heat, and accompanied with noiſe and crackling. This effect is moſt frequently produced by water contained betwixt the parts of a decrepitating body, when theſe parts have a certain degree of adheſion together. This water being quickly reduced into vapors by the heat ſuddenly applied to it, rarefies and burſts with noiſe the parts which compreſs it.

The bodies moſt ſubject to decrepitation are certain ſalts, ſuch as *common ſalt*, *vitriolated tartar*, *nitre of lead*, the decrepitation of all which proceeds from the water of their cryſtallization, *clays* which are not perfectly dry, and *flints*.

DELF-WARE. This is a kind of pottery of baked earth, covered with an enamel or white glazing, which gives it the appearance and neatneſs of porcelain.

Some kinds of this enamelled pottery differ much from others, either in their ſuſtaining ſudden heat without breaking, or in the beauty and regularity of their forms, of their enamel, and of the painting with which they are ornamented.

In general, the fine and beautiful enamelled potteries, which approach the neareſt to porcelain in external appearance, are at the ſame time thoſe which leaſt reſiſt a briſk fire. Again, thoſe which ſuſtain a ſudden heat are coarſe, and reſemble common pottery.

The baſis of this pottery is clay, which is to be mixed when too fat with ſuch a quantity of ſand, that the earth ſhall preſerve enough of its ductility to be worked, moulded, and turned eaſily, and yet that its fatneſs ſhall be ſufficiently taken from it, that it may not crack or ſhrink too much in drying or in baking.

Veſſels formed of this earth muſt be dried very gently to avoid cracking. They are then to be placed in a furnace to receive a ſlight baking, which is only meant to give them a certain conſiſtence or hardneſs. And, laſtly, they are to be covered with an enamel or glazing, which is done by pouring upon the veſſels thus prepared, the enamel which has been ground very fine and diluted with water.

As veſſels on which the enamel is applied are but ſlightly baked, they readily imbibe the water in which the enamel is ſuſpended, and a layer of this enamel adheres to their ſurface. Theſe veſſels may then be painted with colors compoſed of metallic calxes mixed and ground with a fuſible glaſs. When they are become perfectly dry, they are to be placed in the furnace included in caſes of baked earth, called *ſeggars*, and expoſed to a heat capable of fuſing uniformly the enamel which covers them.

This heat, given to fuſe the enamel, being much ſtronger than that which was applied at firſt to give ſome conſiſtence to the ware, is alſo the heat neceſſary to compleat the baking of it. The furnace and the colors uſed for painting this ware are the ſame as thoſe employed for porcelain. *See* PORCELAIN.

The glazing, which is nothing but white enamel, ought to be ſo opake as not to ſhew the ware under it. Many receipts for making ſuch enamels may be found in Neri's Treatiſe on the Art of Making Glaſs, with Kunkel's Notes, and in the Encyclopedia, both which books may be conſulted on this ſubject. We ſhall only obſerve in general, that all theſe enamels for delf-ware are compoſed of ſand or flints, vitrifying ſalts, calx of lead, and calx of tin; and that the ſand muſt be perfectly vitrified ſo as to form a glaſs conſiderably fuſible. Somewhat leſs than an equal part of alkaline ſalt, or twice its weight of calx of lead, is requiſite to effect ſuch vitrification of ſand. The calx of tin is not intended to be vitrified, but to give a white opake color to the maſs; and one part of it is to be added to three or four parts of all the other ingredients taken together.

From theſe general principles, various enamels may be made to ſuit the different kinds of earths to which they are to be applied.

To make this enamel, lead and tin are calcined together with a ſtrong fire, and the ſand is alſo to be made into a fritt with the ſalt or aſhes. The whole is then to be well mixed and ground together. This matter is then to be placed under the furnace, where it is melted and vitrified during the baking of the ware. Then it is to be ground in a mill, and applied as we have directed. *See* CLAY, POTTERY, PORCELAIN, *and* VITRIFICATION. *(m)*

(m) M. Boſc d'Antic has publiſhed a memoir concerning *Delf-ware* in the *Mem. des Sçavans Etrang. Tom.* 6. From this memoir the following obſervations are taken.

Pure clay is not a fit material when uſed alone for the making of Delf-ware. Different kinds of earths mixed together are found to ſucceed better. Pieces of ware made of clay alone would require too much time to dry, they would crack, and would loſe their form, unleſs they were made exceedingly thick. An addition of *marle* is found to leſſen the contraction of the clay; renders it leſs compact; allows the water to eſcape, in the drying of the ware, without alteration of form; and affords a better ground for the enamel, which appears more gloſſy and white, than when laid on clay alone.

The kinds of clay which are chiefly uſed in the compoſition of Delf-ware, are the blue and green. But a mixture of blue clay and marle would not be ſufficiently ſolid, and would be apt to ſcale, unleſs it were expoſed to a fire more intenſe than what is commonly uſed for the burning of Delf-ware. To give a greater ſolidity, ſome red clay is added, which on account of its ferruginous matter poſſeſſes the requiſite binding quality. The proportions of theſe ingredients vary in different works, according to the different qualities of the earths employed. Three parts of blue clay, two parts of red clay, and five parts of marle, form the compoſition uſed in ſeveral manufactories. M. D'Antic thinks that the beſt delf might be made of equal parts of pure clay and

DELIQUESCENCE. We underſtand by deliqueſcence the property which certain bodies have to attract moiſture from the air, and of becoming thereby liquid.

This property is never found but in ſaline ſubſtances, or in matters containing them. It is cauſed by the great affinity which ſaline ſubſtances have with water. Hence, the more ſimple theſe ſubſtances are, the more alſo they are deliqueſcent. Acids, for inſtance, and certain alkalis, which are the moſt ſimple of ſaline ſubſtances, are alſo the moſt deliqueſcent. Mineral acids are ſo deliqueſcent that they ſtrongly imbibe moiſture from the air, although they are already mixed with a ſufficient quantity of water to be fluid. For this purpoſe it is ſufficient that they be concentrated only to a certain degree.

Many neutral ſalts are deliqueſcent, chiefly thoſe whoſe baſes are not ſaline ſubſtances. Their acids are but imperfectly ſaturated; and although they do not give the ſame marks of acidity as when quite diſengaged, they may be conſidered as ſtill poſſeſſing enough of their activity to exerciſe it on the moiſture of the circumambient air. This proves that the acids of neutral deliqueſcent ſalts are in an intermediate ſtate betwixt that of an acid quite diſengaged, and that of one perfectly ſaturated and combined.

All the phenomena which ſalts preſent relatively to their deliqueſcence, are ſo many proofs of what we have affirmed on this ſubject.

Salts formed by vitriolic acid with fixed or volatile alkalis, earths, or metallic ſubſtances, are not deliqueſcent; although this acid be the ſtrongeſt of all, and which, when diſengaged, moſt powerfully attracts moiſture from the air. But its greater ſtrength is the real cauſe of its forming ſo complete and intimate combinations with theſe ſeveral ſubſtances as to form neutral ſalts which are not deliqueſcent.

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pure calcareous earth; but this compoſition would require that the fire ſhould be continued twice as long as it generally is.

The preparation of the white enamel with which this ware is glazed, is another eſſential part, in which many artiſts fail. M. D'Antic recommends for this purpoſe a mixture of a hundred pounds of calx of lead; with about a ſeventh part of that quantity of calx of tin for common delf, or a fourth part of calx of tin for the fineſt delf; a hundred, or a hundred and ten pounds of fine ſand; and about twenty or thirty pounds of ſea-ſalt, or ſalt of glaſs.

The nitrous and marine acids form with abſorbent earths and certain metallic ſubſtances, particularly with iron and copper, deliqueſcent ſalts, from the weakneſs of the union which they contract with theſe matters. Theſe acids form with ſilver, mercury, lead, and biſmuth, ſalts which are not deliqueſcent, becauſe they combine more intimately and completely with theſe latter metals.

Singular phenomena are preſented by vegetable acids relatively to the deliqueſcence of the neutral ſalts formed by them. The acid of vinegar united with fixed vegetable alkali forms a very deliqueſcent ſalt, called *terra foliata tartari*. The ſame acid forms with copper a ſalt that is not deliqueſcent, as we ſee in the inſtance of *cryſtals of copper*. Theſe effects are directly contrary to thoſe produced by the nitrous and marine acids united with the ſame ſubſtances; for theſe acids form with fixed vegetable alkali ſalts which are not deliqueſcent, and with copper ſalts which are very deliqueſcent.

The acid of tartar, which when diſengaged is in a concrete ſtate, and far from being deliqueſcent, ſince it is ſcarcely ſoluble in water, forms with iron (another ſubſtance ſtill leſs ſoluble) a very deliqueſcent ſoluble tartar, known by the name of *tartariſed tincture of iron*.

Many reſearches and experiments remain yet to be made to explain entirely the cauſes of theſe ſingular effects. But probably the deliqueſcence or oppoſite quality of ſalts will be found to depend on the ſtate of their acids, as we have already ſaid.

The fixed vegetable alkali is deliqueſcent, the mineral is not. The cauſe of which undoubtedly is, that the ſaline principle of the latter alkali is combined more intimately, or with a greater quantity of matter not ſaline, than that of the former, as the other properties of theſe two alkalis indicate. *See* ALKALI.

Fixed vegetable alkali treated with quicklime becomes more deliqueſcent. Volatile alkalis, which are naturally not deliqueſcent, become by treatment with quicklime deliqueſcent. We cannot explain theſe phenomena without ſuppoſing that quicklime takes from alkalis in general a portion of oily or other matter, which binds and ſaturates their ſaline principle, when in their natural ſtate.

The dry extracts of almoſt all vegetable matters eaſily moiſten in the air. But they certainly poſſeſs this property ſo much more evidently, as a greater quantity of earthy or reſinous matter, which is always depoſited during the evaporation, has been previouſly ſeparated from their infuſions and decoctions.

Before we finiſh this article we ought to obſerve, that ſome bodies which are not deliqueſcent attract moiſture from the air, and even become liquid, that is, if they be ſaline or ſoluble in water. This happens when bodies are much colder than the air to which they are expoſed. The reaſon of it is, that the moiſture contained in the air being always in the ſtate of inſenſible vapors, is condenſed by the cold of the bodies it touches, and is collected in drops. This effect is very different from a true deliqueſcence; but it deſerves to be taken notice of, to prevent miſtakes in experiments.

Laſtly, we muſt remark, that ſome bodies, after having been a long time expoſed to the air, may remain apparently dry, although they really be in the diſpoſition of deliqueſcent bodies, that is, attract much moiſture from the ambient air. Such, for inſtance, is quicklime, which imbibes from the air its equal weight of moiſture, and retains, notwithſtanding, its dry and powdery appearance. This proceeds from the great quantity of earthy parts with which thoſe parts of the quicklime are mixed, which may be conſidered as deliqueſcent, although, in fact, they do not reſolve into a liquor.

DELIQUIUM. This term is frequently employed by chemiſts to characterize a body which is reſolved into a liquor by expoſure to air. In this ſenſe they talk of the deliquium of a ſalt, as of ſalt of tartar, for inſtance. This word is alſo frequently uſed inſtead of deliqueſcence. Thus we ſay, that a ſalt falls into a deliquium, to ſignify that it is deliqueſcent.

DEMI-METAL. The ſame as SEMI-METAL; *which ſee.*

DEPHLEGMATION. Dephlegmation is an operation by which the ſuperabundant water of a body is taken from it; and it is principally effected by evaporation or diſtillation. Dephlegmation is alſo called concentration, particularly when acids are the ſubject. *See* CONCENTRATION.

DETONATION. By the word *detonation* chemiſts underſtand an exploſion with noiſe made by the ſudden inflammation of ſome combuſtible body. Such are the exploſions of *gun-powder*, *fulminating gold*, and *fulminating powder*. As nitre is the cauſe of moſt exploſions, the word *detonation* has been appropriated to the inflammation of the acid of this ſalt with bodies containing phlogiſton, and it is frequently given to thoſe inflamations of nitrous acid which are not accompanied with exploſion. Thus nitre is ſaid to detonate with ſulphur, with coals, with metals, although in the ordinary method of making theſe operations, that is, in open crucibles, and with ſmall quantities of detonating ſubſtances, the nitre does not truly explode.

DETONATION *of* NITRE. The detonation of nitre is one of the moſt important phenomena of chemiſtry. It conſiſts in the inſtantaneous inflammation and decompoſition of the acid of nitre, when it immediately touches combuſtible bodies, the phlogiſton of which is ignited, or when the acid is ignited.

By two methods then may nitre, or rather its acid be inflamed. The firſt method is by applying it to a red-hot combuſtible body; and the ſecond is by making the acid itſelf red-hot, and applying a combuſtible body to it in that ſtate.

A very neceſſary remark is, that nitre cannot detonate without the concurrence of theſe circumſtances now mentioned. Nitre may be made red-hot, or of any degree of heat, without ſhewing any ſign of inflammation, provided it does not touch any inflammable matter.

On the other ſide, nitre may be heated, and a combuſtible body applied to it without any inflammation. For this purpoſe, the nitre need only be not ſufficiently hot to kindle the inflammable bodies applied to it. Meſſrs. Macquer and Beaumé ſhow, in their courſe of chemiſtry, an experiment which clearly proves this truth. Some nitre is put into a crucible, and there completely fuſed by a heat juſt ſufficient for that purpoſe: when a black coal is thrown into this fuſed nitre, no inflammation ariſes, becauſe the nitre may be melted with a degree of heat which is not ſufficient to kindle combuſtible bodies; and this degree of heat is neceſſary for the ſucceſs of the experiment.

But when nitre is red-hot, and a coal is applied to it, kindled, or not kindled, then it is inflamed with violence, and makes the coal burn rapidly. The ſame event happens when nitre is thrown upon burning coals. This inflammation laſts while theſe two ſubſtances touch, and any acid remains in the nitre. During this detonation a conſiderable ſmoke riſes; but this ſmoke contains no acid, as the experiment of the clyſſus of nitre made in cloſe veſſels ſufficiently proves. *See* CLYSSUS *of* NITRE.

When all the nitrous acid is thus burnt, and no longer any inflammation is excited, although more coals are added, if we examine what remains in the crucible, we ſhall find that it is the fixed alkali which was the baſis of the nitre. This alkali is called *fixed* or *alkaliſed nitre. See theſe words, and* ALKALI (FIXED VEGETABLE.)

The detonation may be rendered more eaſy and ſudden by making the nitre touch the inflammable matter in a greater number of parts; ſo that when theſe two ſubſtances are divided into very minute parts, which are well mixed and interpoſed betiwxt each other, the detonation is almoſt inſtantaneous, and is as ſtrong as it can be made. When the ſubſtances are thus prepared, they may be at once inflamed by a ſmall ſpark of ignited matter; becauſe the ignition is very quickly and almoſt inſtantaneouſly communicated by ſmall intervals. From the accurate mixture of the two detonating ſubſtances proceeds the great force and violence of *gun-powder. See* POWDER (GUN).

Hence we may learn to avoid the violence of detonations in chemical operations, by mixing very imperfectly the nitre with the combuſtible ſubſtances.

Let us now conſider what paſſes in the detonation of nitre. Mr. Macquer, in his Elements of Chemiſtry, conjectures that the detonation of nitre, which is, properly ſpeaking, the inflammation of the nitrous acid, cannot take place, unleſs a combination be previouſly formed betwixt this acid and the phlogiſton of the combuſtible ſubſtance uſed for the detonation; that this combination is entirely ſimilar to that of vitriolic acid with phlogiſton when ſulphur is formed; and that, in the preſent inſtance, *a nitrous ſulphur* is produced; but that this ſulphur is infinitely more combuſtible than the vitriolic ſulphur, for a reaſon we ſhall ſoon ſee, and even ſo combuſtible, that it cannot exiſt an inſtant without being entirely burnt; hence it is inflamed with extreme rapidity and violence as ſoon as it is formed.

The moſt eſſential circumſtances attending the detonation of nitre concur in rendering this opinion probable, that is, to eſtabliſh the preliminary exiſtence of this nitrous ſulphur.

Firſt, vitriolic ſulphur cannot be formed by vitriolic acid engaged with a fixed alkali, unleſs this acid be deprived of all the water ſuperabundant to its ſaline eſſence, and in a dry ſtate, when it is applied to phlogiſton.

In the ſecond place, to effect this combination, a degree of heat equal to that of ignition muſt be applied.

Thirdly, as in ſulphur not a particle of oil exiſts, but the vitriolic acid is united to pure phlogiſton, as the illuſtrious Stahl has fully demonſtrated; if, therefore, an inflammable matter, which is in an oily ſtate, be uſed for the formation of ſulphur, it muſt be firſt decompoſed, and reduced to the ſtate of coal, before the ſulphur can be produced. *See* SULPHUR. But theſe are preciſely the ſame conditions which are neceſſary for the detonation of nitre; for ſince the acid of nitre cannot detonate unleſs it be ignited, it muſt be evidently deprived of all the water ſuperabundant to its ſaline eſſence.

In the ſecond place, experience ſhews that nitre cannot detonate with any matter which is in an oily ſtate; for if nitre be ignited in a crucible, and oil, reſin, fat, or other inflammable matter of this kind be added to it, no detonation will happen while the inflammable matter remains in its oily ſtate, or till it be burnt, decompoſed, and reduced to a coal; then the detonation commences, and is always proportionable to the quantity of coal produced by the inflammable matter.

Some ſubſtances, the phlogiſton of which is certainly in an oily ſtate, ſuch as tartar, ſaw-duſt of wood, and others of this kind, do indeed detonate with nitre almoſt as readily as powder of charcoal: but we may eaſily perceive that the cauſe of this is, that the oil of theſe ſubſtances, being divided by the interpoſition of a large quantity of incombuſtible matters, may be exceedingly ſoon reduced to the ſtate of coal by the heat of ignition.

Several facts intimately connected with the detonation of nitre may be naturally deduced from this theory, and conſequently become additional proofs of it.

Let nitrous acid, as much dephlegmated as poſſible, be poured upon black coals, as dry and hot as they can be made, under a red-heat, no detonation or inflammation will enſue. This is not ſurpriſing, ſince all the neceſſary conditions for the production of nitrous ſulphur are wanting here, and ſince, in ſimilar circumſtances ſulphur could not be formed by vitriolic acid.

If an ardent coal be plunged into the ſtrongeſt nitrous acid, a detonation begins at the ſurface of the coal, which very ſoon ceaſes; the coal is extinguiſhed, becomes black, and is not affected by the acid. The ſhort detonation upon the ſurface of the coal may be conſidered as accidental, and not belonging to the experiment; otherwiſe the detonation would continue while the acid laſted. This detonation can only be cauſed by a ſmall quantity of nitre, formed inſtantaneouſly by the acid uniting with ſome ſmall portion of alkaline ſalt contained in the aſhes of the coal, which happen to lie on its ſurface: therefore, when this ſmall quantity of nitre is conſumed, the coal is extinguiſhed, and the detonation ceaſes; and all this ought to happen becauſe the moſt dephlegmated nitrous acid contains always a conſiderable quantity of water ſuperabundant to its ſaline eſſence; and as it is not in the preſent experiment retained or fixed by any baſis, it diſſipates in vapors before it can be totally dephlegmated by the heat of the ardent coal: hence in this experiment no nitrous ſulphur can be formed; neither can vitriolic acid form vitriolic ſulphur in ſimilar circumſtances, but only volatile ſulphureous acid.

From theſe facts we may conclude, that nitrous acid, while free, that is, not engaged in any baſis, cannot ever contract with phlogiſton ſuch an union, as that a ſulphureous compound, or nitrous ſulphur, ſhall be formed; not only becauſe of the ſuperabundant water it always contains, but alſo becauſe, from its want of fixity, it cannot be deprived of this ſuperabundant water in the very act of combination: we may therefore affirm as a general and eſtabliſhed principle, that diſengaged nitrous acid is not capable of detonation. If then this pure acid inflames oils mixed with it, this inflammation proceeds from a very different cauſe than the true detonation of nitre, as Mr. Macquer has ſhewn in his Elements of Chemiſtry; nitre and diſengaged nitrous acid being very different from each other, particularly with regard to detonation. *See* INFLAMMATION *of* OILS.

What we have ſaid on this ſubject clearly ſhews why combinations of nitrous acid with certain baſes form nitres ſuſceptible of a ſtrong detonation, while others of the ſame acid with different baſes detonate weakly or not at all; theſe differences depending on the greater or leſs adheſion of the nitrous acid with its baſis. All thoſe nitrous ſalts in which the acid is ſo firmly fixed and retained by its baſis, that it may be entirely dephlegmated and ignited, are ſuſceptible of a ſtrong detonation; ſuch are *ordinary nitre*, *cubic nitre*, *nitrous ammoniacal ſalt*, *nitres of ſilver*, *of mercury*, *of lead*, *and of biſmuth*; of all which ordinary nitre detonates moſt violently, and is the only one of which good gunpowder can be made; becauſe the fixed vegetable alkali, which is the baſis of nitre, has a ſtronger adheſion to

nitrous

nitrous acid than any other of the ſubſtances ſoluble by this acid.

On the contrary, all combinations in which nitrous acid is only weakly united, do not detonate, or very weakly. Such are *nitres with baſes of calcareous earths*, *of copper*, *(n)* *of*

(n) Nitre with baſis of copper is capable of detonating by contact with tin ; the nitrous acid acting on the tin ſo violently as to produce heat ſufficient for the detonation. This experiment is thus deſcribed by *Dr. Higgins*, in the *Phil. Tranſ. Vol.* 63.

" Several pieces of thin ſheet-copper placed vertically and at a ſmall diſtance from each other in the ſtrong nitrous acid, diluted with half its quantity or more of water, and ſuffered to remain in a cloſe veſſel until the acid is ſaturated, afford a cryſtalline blueiſh-green ſalt, which is to be ſeparated from the undiſſolved copper and the ſuperfluent green liquor, and kept in a well corked bottle ; becauſe on expoſure to air it deliqueſces.

" This ſalt taken moiſt, but not very wet, and beaten to the fineneſs of baſket ſea-ſalt in a mortar, is to be ſtrewed to the thickneſs of a ſhilling on a piece of tin-foil twelve inches in length and three in breadth.

" Then the foil is to be inſtantly rolled up ſo as to include the ſalt as it lay between the coils. The ends are to be ſhut by pinching them together, and the whole is to be preſſed flat and cloſe.

" All this being done as quick as poſſible, the firſt phenomenon is, a part of the ſalt deliqueſces.

" 2. This part impregnated with tin changed in color, and of a thicker conſiſtence, begins to froth forth from the ends of the coil.

" 3. A ſtrong frothing, accompanied with moderate warmth.

" 4. The emiſſion of copious nitrous fumes.

" 5. Heat intolerable to the fingers.

" 6. Exploſion and fire which burſt and fuſe the tin-foil in ſeveral places, if it be very thin.

" After many experiments and conjectures, I diſcovered a property in the cupreous ſalt, from which, and the known affinities of the bodies concerned, theſe appearances may be accounted for.

" The cupreous ſalt properly dried and placed where it can receive a heat not much greater than what the hand can bear, takes fire. The circumſtances which favour this ignition, and contribute to produce it in the ſmalleſt degree of heat, concur in the following convenient method of trying the experiment.

" A piece of ſoft bibulous paper is to be dipped in the nitrous ſolution of copper, and dried before the fire two or three times alternately. Then it is to be approached towards the heat, as near as can be borne by the hand which holds it without pain ; there, *of iron*, *of tin*, *of regulus of antimony*; theſe being all nitrous ſalts in which the acid adheres weakly; as their deliqueſcent quality, and the facility with which fire detaches this acid from them, ſufficiently ſhew.

We ſhall now examine what happens in the very act of the detonation of nitre, or rather in the deflagration of nitrous ſulphur. We have ſeen that this ſulphur is formed in the ſame circumſtances as vitriolic ſulphur: but if theſe two compounds reſemble each other in the manner of their production, they differ entirely in the phenomena of their combuſtion.

Vitriolic ſulphur burns very weakly; produces a flame which is very little luminous; requires for the continuance of its burning a conſtant ſupply of new air; and its acid undergoes no change by this combuſtion. Nitrous ſulphur,

there, if it has been ſufficiently dried, it will preſently catch fire and burn to a brown calx. The eaſy ignition of the ſalt in a ſlight heat being thus aſcertained, there is no room to doubt that the foregoing phenomena are produced in the following manner:

"The acid of the liquor which moiſtened the ſalt quits the copper to unite with the tin, leaving the water to be imbibed by the contiguous ſalt of copper which then diſſolves, and acts briſkly upon, the tin-foil.

"It is well known that the action of the nitrous acid on tin is always accompanied with conſiderable heat and effervеſcence, and that the ſolution of metallic ſalts in watery liquors is haſtened by heat.

"In our experiment, the warmth generated by the firſt action of the cupreous ſolution promotes the deliqueſcence of the cryſtallized ſalt. The union of the acid with the tin is rapid, not only as being aſſiſted, but on account of the great ſurface expoſed; whence the ſtrong frothing, and the extraordinary heat by which the redundant moiſture is carried away, and the undecompoſed part of the cupreous ſalt, together with that lately formed with the tin, perfectly dried.

"The heat generated upon both ſurfaces of a large expanſe of tin, is concentrated by cloſely coiling it into a ſmall compaſs, and being retained by the various ſurrounding laminæ of metal, it is neceſſarily accumulated to a quantity; which, if we may judge from the touch, is more than ſufficient to fire the dry cupreous ſalt.

"The ſalt formed with tin, and the nitrous acid, burns and ſparkles in a red heat. Catching fire, therefore, from the ignited cupreous ſalt, it burns with it, and aſſiſts in the detonation, which is common to all nitrous compoſitions in ſimilar circumſtances."

on the contrary, appears incapable of exiſting an inſtant without burning. Its vivid, dazzling flame, accompanied with noiſe, reſembles the flame of a fire ſtrongly actuated by a blaſt of air; it needs not the contact of external air; it burns with the ſame violence and rapidity in cloſe veſſels; no obſtacle is capable of containing it: and if it be confined, it burſts with a terrible noiſe the ſides of the confining veſſels; laſtly, after its combuſtion no trace is found of its acid.

What can be the cauſe of ſo conſiderable differences? and how are ſo ſingular phenomena produced? We cannot do better than adopt entirely the theory of Stahl. This great chemiſt has explained all theſe effects in a manner the moſt ſatisfactory, and the moſt conformable to the principles of rational chemiſtry.

Stahl conſiders nitrous acid as compoſed of a watery principle, and of an earthy principle, as well as all other acids: but he alſo admits a third element to enter into this acid, by which it is characteriſed, and by which it differs from vitriolic acid. This third principle of nitrous acid is phlogiſton; but this principle is ſo proportioned and combined with the other two, that nitrous acid is not inflammable while alone, even when it is ignited: but if a new quantity of inflammable principle unites with nitrous acid, (which happens in the production of nitrous ſulphur) then the proportion of this principle being encreaſed, it accordingly aſſumes all the properties, and particularly the inflammability, which is eſſential to it. Hence nitrous acid cannot be combined with a body containing phlogiſton, ſo diſpoſed as to be capable of forming with it an intimate union; that is, a nitrous ſulphur, without producing an inflammation. If, then, phlogiſton united intimately with vitriolic acid forms vitriolic ſulphur, which is much leſs inflammable, this happens becauſe phlogiſton is not one of the principles of vitriolic acid, and does not enter into its combination, as it enters into that of nitrous acid.

From this cauſe alſo, namely the exiſtence of phlogiſton in nitrous acid, as a principle, Stahl deduces the deſtruction or total decompoſition of this acid, when it is inflamed, and this he does upon good grounds; for then not only the phlogiſton which is combined ſuperabundantly with nitrous acid is inflamed, but alſo this ſuperabundant phlogiſton, finding itſelf mixed and confuſed with the phlogiſton which is a principle of nitrous acid, takes this along with it in its inflammation, and the whole is entirely conſumed.

This being eſtabliſhed, we ought not to wonder that no nitrous acid is found after the detonation; for every compound body, from which one of its principles is taken, is thereby neceſſarily decompoſed. If the inflammable principle of this acid could be conſumed without deſtroying the connexion of the other principles, we ſhould not indeed find after detonation any nitrous acid: becauſe the phlogiſton, its diſtinguiſhing principle, would have been taken from it; but as, according to Stahl, the union of the two principles, the watery and the earthy, is ſufficient to conſtitute an acid, we ſhould ſtill find an acid ſubſtance of a different nature from nitrous acid, nearly in the ſame manner that we find pure vitriolic acid, after the portion of phlogiſton which had conſtituted it volatile ſulphureous acid, has been taken from it: but things paſs quite otherwiſe in the inflammation of nitrous acid; not a veſtige remains of this, or of any other acid; nothing is found again but earth and water. This ſhews the connexion of the principles of nitrous acid to be ſuch, that one of its conſtituent parts cannot be taken from it without an entire disjunction of the others; ſo that after its inflammation, it does not exiſt, neither as nitrous, nor as any other acid.

We may eaſily perceive how much theſe facts, and the conſequences reſulting from them, give probability to the opinion of Stahl, who thinks that every acid, in general, reſults from an union of a watery with an earthy principle; and that the particular and ſpecific properties of the ſeveral acids are cauſed by ſome other principle, which enters into their combination with theſe two eſſential conſtituent parts.

The exploſion accompanying the detonation of nitre, and which is ſo much more violent as the matters have been more perfectly mixed, and more cloſely compacted, proceeds from a great and ſudden dilatation of ſome very expanſible body. Moſt natural philoſophers have attributed it to air contained in nitre, and in matters with which the nitre detonates; becauſe air included and rarefied is capable of producing, and does produce, very violent exploſions: nevertheleſs, we muſt obſerve, that none of the exploſions of air are equal in violence to thoſe of gunpowder, of fulminating-powder, and of fulminating-gold, which are certainly effects of the inflammation of nitrous acid.

Theſe conſiderations alſo incline us to adopt the opinion of Stahl on this phenomenon: This chemiſt thinks, that theſe exploſions ought not to be attributed to the air, but to the water of the nitre, or rather of its acid; which is capable of producing much more violent exploſions than thoſe of air, when a ſtrong heat, ſuch as that of red-heat, is ſuddenly applied to it, as happens in the detonation of nitre. *See* WATER.

The ſame chemiſt goes farther. He advances, not without much probability, that water, the aggregation of which is entirely broken, acquires the properties of air. Upon this ſuppoſition we may well explain why nitre is capable of burning with combuſtible ſubſtances, without the acceſs of air, and in cloſe veſſels. The reaſon of this is, that nitre contains in its own ſubſtance a matter which is diſengaged during the deflagration, and which, if it is not air, has, as well, or better, the property of maintaining combuſtion. The flame iſſuing from nitre, when made to detonate ſo ſlowly that it can be obſerved, ſeems to prove what we have advanced on the ſubject; for it has, as we have ſaid, all the appearance of the flame of a body excited ſtrongly by a blaſt iſſuing from its own centre. *(o)*

Nitre detonates with ſulphur, and with thoſe metallic ſubſtances the phlogiſton of which is ſo diſpoſed that it can eaſily burn; ſuch are iron, tin, zinc, and others of this nature. This detonation has nothing peculiar; it muſt happen not only from the combuſtibility of the phlogiſton of theſe ſubſtances, but alſo becauſe this phlogiſton is not in the ſtate of oil. What we have ſaid concerning the

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(o) The exploſion of nitre deflagrated with inflammable ſubſtances is cauſed by an elaſtic fluid, which is produced from the nitre and theſe ſubſtances by deflagration. This fluid is not the water of the nitre rarefied and converted into air; for the water of the nitre is only rarefied by the heat of the deflagration, and is afterwards by cold condenſed, forming the water called clyſſus of nitre. *See* CLYSSUS *of* NITRE. But the elaſtic fluid produced by deflagration is permanent, and not condenſible into a liquid. Mr. Robins found, by accurate experiments, that the fluid produced by firing gun-powder, when confined within a ſpace equal to that of the gun-powder which was fired, and reduced to the heat of the atmoſphere, was capable of ſuſtaining a preſſure equal to 244 times the preſſure of the atmoſphere; and that the elaſtic force of the fluid was increaſed probably about four times by the heat produced by the firing of the powder; and conſequently that it is thereby rendered capable, at the inſtant of exploſion, of ſuſtaining a preſſure nearly equal to a thouſand times the preſſure of the atmoſphere. *See* Robins's *Principles of Gunnery.*

detonation of nitre by coals, is applicable to thoſe which are now treated. However, attention muſt be given to the other principles of theſe ſubſtances, and to the greater or leſs quantity, and degrees of combuſtibility of their phlogiſton.

DEW. Formerly this name was given to the phlegm that roſe firſt in the diſtillation of ſeveral ſubſtances. Thus the *dew of vitriol*, *the dew of honey*, were watery liquors which roſe firſt when theſe ſubſtances were diſtilled.

DIAMOND. Diamonds are ſtones of the vitrifiable kind, which are found naturally cryſtallized, nearly as rock-cryſtal is, in form of ſix-ſided priſms, each extremity of which is terminated by a pyramid alſo of ſix ſides. Some diamonds, however, are differently cryſtallized.

Diamonds are the moſt beautiful and the deareſt of all precious ſtones. They are of different colors, particularly yellow; but the greateſt part of them are white, and amongſt theſe, the whiteſt and moſt tranſparent are of higheſt value. No ſtone is harder than the diamond; it is alſo very refractory, and even apyrous; it has all the properties of vitrifiable ſtones, with this difference, that it requires more fire, and a larger quantity of flux to produce its vitrification than any other of the ſubſtances of the ſame kind. *See* STONES (VITRIFIABLE). *(p)*

DIA-

(p) Diamonds are the hardeſt and moſt brilliant of all ſtones. They are either hexagonal priſms terminated by eight-ſided points or pyramids; or they are flat, or cubical, or rounded. Whether this difference of form be original, or adventitious, has not been determined. The firſt kind are the beſt and hardeſt, and may therefore have preſerved their original form againſt accidents better than the others, eſpecially than thoſe which are rounded, which are ſaid to be the leaſt hard, and conſequently moſt liable to have their forms altered by attrition Diamonds are ſaid to conſiſt of laminæ or plates, and probably they have ſome uniform texture; becauſe lapidaries find that they may be poliſhed much more eaſily in one than in any other direction. This ſtone becomes luminous in the dark by expoſure during a certain time to the rays of the ſun; by heating it in a crucible; by plunging it in boiling water; or by rubbing it with a piece of glaſs. By friction it acquires an electrical property, by which it attracts the ſubſtance uſed for foils, called black maſtic, and other light matters. The author of the Dictionary, ſays, that diamonds are refractory in the fire, and even apyrous. Neverthele ſs, experiments have been made, which prove that diamonds are capable of being diſſipated, not only by the collected heat of the ſun, but

DIAPHORETIC ANTIMONY. This is a white calx of antimony, made by calcining antimony with thrice its quantity of nitre. *See* ANTIMONY.

alſo by the heat of a furnace, Mr. Boyle ſays, that he perceived certain acrid and penetrating exhalations from diamonds expoſed to fire. A diamond, by expoſure to a concave ſpeculum, the diameter of which was forty inches, was reduced to an eighth part of its weight. *See Phil. Tranſ.* No. 386. In the *Giornale de Letterati d' Italia, Tom.* viii. *Art.* 9. we may read a relation of experiments made on precious ſtones, by order of the Grand Duke of Tuſcany, with a burning lens, the diameter of which was two thirds of a Florentine ell, near the focus of which was placed another ſmaller lens. By theſe experiments we find that diamonds were more altered by ſolar heat than moſt of the other precious ſtones, although not the leaſt appearance of a commencing fuſion was obſervable. A diamond weighing thirty grains, thus expoſed during thirty ſeconds, loſt its color, luſtre, and tranſparency, and became of an opake white. In five minutes, bubbles appeared on its ſurface; ſoon afterwards it burſt into pieces, which were diſſipated; and the ſmall fragment which remained was capable of being cruſhed into fine powder by the preſſure of the blade of a knife. Neither the addition of glaſs, flints, ſulphur, metals, or ſalt of tartar prevented this diſſipation of diamonds, or occaſioned any degree of fuſion. By this heat rubies were ſoftened, and loſt ſome of their color, but preſerved their form and weight. By addition of a third lens, a further degree of fuſion was given to rubies. Even then rubies could not be made to unite with glaſs. By having been expoſed to this heat, the ſurface of the rubies which had ſuffered fuſion, loſt much of their original hardneſs, and were nearly as ſoft as cryſtal. But their internal parts, which had not been fuſed, retained their hardneſs. Emeralds by this heat were rendered white, or of various colors, and ſoon afterwards were fuſed. They were found to have loſt part of their weight, and to be rendered leſs hard and brittle.

Experiments were alſo made by order of the Emperor Francis I. on precious ſtones, from which we find, that diamonds were entirely diſſipated by having been expoſed in crucibles to a violent fire of a furnace during twenty-four hours; while rubies by the ſame heat were not altered in weight, color, or poliſh. By expoſing diamonds during two hours only at a time, the alterations produced on them by fire were obſerved. Firſt, they loſt their poliſh, then they were ſplit into thin plates, and, laſtly, totally diſſipated. By the ſame fire, emeralds were fuſed. *See Magaſin de Hambourg, Tom.* xviii.

The action of fire on diamonds has, notwithſtanding the above mentioned experiments, been lately doubted in France, and the queſtion has been agitated by ſeveral eminent chemiſts, with

DIGESTION. Digeſtion is an operation which conſiſts in expoſing bodies to a gentle heat, in proper veſſels, and during a certain time.

This

much intereſt, and numerous experiments have been made, which throw much light on the ſubject. M. D'Arcet found not only that diamonds included in porcelain crucibles cloſe, or covered with perforated lids, and expoſed to the long and intenſe heat of a porcelain furnace, were perfectly diſſipated ; but alſo, that this ſtone could in a few hours be totally volatiliſed with a much inferior degree of heat, by expoſing them in a coppel under the muffle of an eſſay-furnace. In this latter experiment, he obſerved that the diſſipation was gradual, and that it was effected by a kind of exfoliation. The diſſipation of diamonds expoſed in coppels was confirmed by M. Macquer, who further obſerved, that the diamonds were, before the diſſipation began, rendered, by the fire, brilliant and ſhining, as it were, with a phoſphoric light. In order to determine whether the diſſipation of diamonds was actually effected by their reduction into vapor, or by a combuſtion or other effect of air upon them, Meſſrs. Lavoiſier, Macquer, and Cadet expoſed diamonds to intenſe heat in an earthen retort, during ſeveral hours, but without any other effect than that their poliſh was deſtroyed, and about $\frac{1}{7}$th of their weight diminiſhed. M. Mitouard put diamonds in a tobacco-pipe filled with pounded charcoal and accurately cloſed with lute. He further ſecured the diamonds from acceſs of air or flame, by placing the tobacco-pipe in a crucible to which another crucible was inverted and carefully luted. The diamonds thus ſecluded from external air having been expoſed to the moſt intenſe heat which could be excited in a well conſtructed furnace, were not thereby altered or diminiſhed. M. Mitouard was induced to believe, that the charcoal conduced to the preſervation of diamonds not merely by excluding the air, but by ſome peculiar property, which he ſuppoſes may be the ſame as that by which this ſubſtance defends metals from deſtruction by fire. He was confirmed in his opinion, by obſerving that diamonds were not preſerved from the action of fire by ſurrounding them with powder of chalk, and of calcined hartſhorn, and including them in cloſe veſſels, ſo well, as when the charcoal had been employed. Some chemiſts even thought that the perfect excluſion of air alone was ſufficient to preſerve diamonds, and doubted whether the balls and crucibles of porcelain employed by M. D'Arcet had excluded the air with ſufficient accuracy. Indeed, in one of M. D'Arcet's own experiments, a diamond included in a ball of porcelain had reſiſted the action of fire. In order to aſcertain this queſtion, M. Cadet expoſed diamonds in covered and luted crucibles to the violent heat of a forge during two hours ; by which operation the diamonds

loſt

This operation is very uſeful to favor the action of certain ſubſtances upon each other; as, for example, of well calcined, dry fixed alkali upon rectified ſpirit of wine. When theſe two ſubſtances are digeſted together in a matraſs, with a gentle ſand-bath heat, the ſpirit of wine acquires a yellow-reddiſh color, and an alkaline quality. It is then called *alkaline tincture*, or *tincture of ſalt of tartar*. *See* TINCTURE *of* SALT *of* TARTAR. The ſpirit would not ſo well acquire theſe qualities by a ſtronger and ſhorter heat.

Digeſtion is alſo uſed to ſoften and open certain bodies deſigned to undergo further operations, or to excite in them a certain degree of fermentation.

DISTILLATION. Diſtillation is an operation by which the fluid and volatile principles of bodies may be ſeparated and collected with a convenient degree of heat.

If compounds containing volatile and fixed principles be expoſed to fire, the former being rarefied by heat will endeavour to ſeparate themſelves from the latter; and if the effort which they make for this purpoſe be ſuperior to the coheſion which they have with the fixed principles, a ſeparation will happen, and they will be diſſipated in the ſtate of vapor.

The different fixity and volatility, which the ſeveral principles of almoſt every compound body have, furniſh a very extenſive method of ſeparating and obtaining their principles. This chemiſts effect by diſtillation,

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loſt only $\frac{1}{15}$th part of their weight. He infers, that the deſtruction of diamonds by fire in open veſſels is not a true volatilization, but merely an exfoliation, cauſed by the fire expanding the air contained between the thin plates, of which theſe ſtones conſiſt, and that by this exfoliation or decrepitation, theſe plates are reduced to ſo fine a powder as to eſcape obſervation. M. D'Arcet objected againſt the experiments of his adverſaries that they were not of ſufficient duration to decide againſt his which had laſted ſeveral days. He renewed and multiplied his experiments, which confirmed him in his opinion of the volatiliſation of diamonds in veſſels perfectly cloſed; and that this effect of fire on diamonds is not a mere exfoliation or mechanical ſeparation of the plates of which theſe ſtones conſiſt, he infers from the parts of the diamonds pervading the moſt ſolid porcelain crucibles without being perceptible, and from the luminous appearance firſt noticed by M. Macquer, and which was afterwards obſerved by M. Roux to be an actual flame.

Diſtillation requires an apparatus of veſſels ſuited to the nature of the ſubſtances to be treated, and of the principles to be obtained.

If the ſubſtance to be diſtilled be very compound, very ſuſceptible of alteration by heat, and containing very volatile principles, ſuch as moſt odoriferous plants, ſpirituous liquors, and others of this nature; a veſſel muſt be uſed called an *alembic*, which muſt alſo be provided with a water-bath. *See* ALEMBIC.

As in the diſtillation made with an alembic the vapors riſe vertically, and are condenſed in the upper part of the veſſel called its *capital* or *head*, this method of diſtillation has been called *per aſcenſum*. By this method may be diſtilled all matters volatile enough to riſe with a degree of heat not exceeding that of boiling water: ſuch are the *ſpiritus rector of plants*, *ardent ſpirits*, and all *eſſential oils*.

When compound bodies are to be diſtilled, the moſt volatile parts of which require a heat ſuperior to that of boiling water, *retorts* muſt be employed; becauſe theſe veſſels may be conveniently placed either in a ſand-bath or in a naked fire, and may be ſo diſpoſed in a reverberatory furnace, that the matter which they contain ſhall be equally heated on all ſides.

The ſhape of a retort is ſuch, that principles reduced to the ſtate of vapor cannot iſſue but laterally through the neck of the veſſel, which is accordingly placed on one of its ſides. This diſtillation has thence been called *per latus*. *See* RETORT.

This ſecond method of diſtilling is very uſeful, and may be applied to obtain eſſential oils, heavy acids, eſpecially mineral acids, and ſometimes even very volatile ſubſtances; as for example, the volatile alkali from ſal ammoniac, or from animal matters which have not undergone putrefaction.

A third kind of diſtillation is called *per deſcenſum*; becauſe it conſiſts in applying the heat above the bodies whence the volatile parts are to be extricated; and by this method theſe volatile parts are obliged to deſcend into a veſſel prepared for their reception. But this method of diſtillation has many faults, is abſolutely unneceſſary, and is entirely neglected.

We may eaſily conceive what paſſes in diſtillation. Volatile ſubſtances are rendered by a ſuitable heat ſpecifically lighter, are reduced to the ſtate of vapor, and would be diſſipated, if they were not retained, and obliged to paſs into colder places, where they are condenſed and become liquors, if ſuch be their nature; or elſe they collect in ſmall ſolid particles called *flowers*, and in this caſe the operation changes its name, and is called *ſublimation*. *See* SUBLIMATION.

As diſtillation is always performed in cloſe veſſels, the matters which riſe are excluded from the acceſs of air, which accelerates the aſcent of volatile bodies. *See* AIR.

Hence diſtillations and ſublimations, which are, properly ſpeaking, only evaporations in cloſe veſſels, are more diſadvantageous than evaporations in open air. This is an inconvenience in all caſes where diſtillation may be carried on very faſt without any accident. Such, for inſtance, is the diſtillation of water alone. This inconvenience may be in a great meaſure remedied by introducing into the cucurbit a current of air by means of a ventilator, according to a method propoſed by an Engliſh chemiſt to accelerate the diſtillation of ſea-water, with a deſign to obtain by that means freſh water from it.

But in diſtillations of almoſt all other ſubſtances, this ſlowneſs occaſioned by want of air is rather uſeful than diſadvantageous; becauſe the more ſlowly a volatile ſubſtance is ſeparated from a fixed ſubſtance, the more perfect is the ſeparation. For this reaſon, when a diſtillation is required to be performed according to the rules of the art, it muſt be ſo conducted that no more heat ſhall be applied to raiſe the volatile body than is neceſſary. This management is particularly neceſſary when there is not a great difference betwixt the volatility of the ſeveral principles of the body diſtilled. We have an evident example of this in all concrete oily matters. When we intend to ſeparate the acid and the oil of which theſe matters conſiſt, as theſe two principles have nearly the ſame volatility, they riſe together, and are not diſunited; ſo that the compound body paſſes in diſtillation without ſuffering any decompoſition. *See* BUTTER. Notwithſtanding the moſt careful management of moſt diſtillations, the volatile principles are ſeldom obtained perfectly free from the other principles of the compound; and therefore, to be purified, muſt be ſubmitted to new diſtillations, called *rectifications*.

We may then eſtabliſh, as general and eſſential rules of diſtillation, that no greater heat ought to be applied than is juſt neceſſary to raiſe the ſubſtances to be diſtilled; and that the ſlowneſs of the operation is no leſs advantageous than the hurrying of it too much is prejudicial.

Theſe rules ought alſo to be obſerved for ſome other very ſtrong reaſons. Such is the prevention of the breaking of veſſels, which frequently happens in thoſe of glaſs or of earthen ware when they are too ſuddenly or too ſtrongly heated, and moſt certainly happens when the vapors riſe more quickly than they can be condenſed.

Theſe accidents are chiefly occaſioned by vapors which are very elaſtic and not eaſily condenſible. Some vapors, as theſe of the ſmoking nitrous and marine acids, have theſe qualities ſo ſtrongly, that much of them is loſt, by the neceſſity of giving frequently a vent to them, by unſtopping a ſmall hole made in the balloon employed as a receiver in ſuch diſtillations, and which might be conveniently made in all receivers *.

DITTANY *of* CRETE. *(q)*

DIVISION. By *diviſion* we ought to underſtand that ſeparation which is occaſioned in the parts of a body by help of mechanical inſtruments.

The mechanical diviſion of bodies does indeed ſeparate them into ſmaller, homogeneous, ſimilar parts; but this ſeparation cannot extend to the primary integrant molecules of any body, and conſequently is incapable of breaking what is properly called their aggregation: alſo, no union is formed betwixt the divided and dividing bodies, in which reſpect diviſion eſſentially differs from *ſolution*.

Diviſion is not properly a chemical operation. It is only employed preparatorily to facilitate other operations, and particularly ſolution. For this purpoſe it is very uſeful, as it encreaſes the quantity of ſurface, and conſequently the points of contact of any body.

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* *See* PLATE I. where the veſſels uſed in diſtillations are repreſented. See alſo the Explanation of the Plates, where an apparatus is deſcribed, by which the fumes that uſually eſcape in the diſtillation of very volatile liquors are condenſed.

(q) DITTANY *of* CRETE. Sixteen ounces of the leaves of this plant yield about half a dram of a ſtrong, aromatic, eſſential oil, which coagulates by cold, reſembling camphor. From an ounce of this plant Neuman obtained with water two drams and a ſcruple of extract; and from the ſame quantity, with ſpirit of wine, he obtained a dram and a half of reſinous extract. He obſerves, that the green color of the leaves reſides in the reſin, and is extractable by ſpirit, eſpecially after water has previouſly extracted the gummy part, ſome of which being alſo ſoluble by ſpirit along with the reſin, alters the color of the ſpirituous tincture.

Different methods are uſed to divide bodies according to their nature. Thoſe which are tenacious and elaſtic, as horns and gums, require to be cut, raſped, or filed. Metals, becauſe of their ductility, require the ſame treatment: but as they alſo are fuſible, they may be quickly and conveniently reduced into grains ſmall enough for moſt operations, by pouring them, when melted, into water.

All brittle bodies may be reduced conveniently into fine parts by being bruiſed in a mortar with a peſtle.

Very hard bodies, ſuch as glaſs, cryſtals, ſtones, particularly thoſe of the vitrifiable kind, before they are pounded, ought to be plunged when red-hot into water, by which they are ſplit and cracked, and rendered more eaſily pulverable.

Bodies of this kind may alſo be bruiſed or ground by means of a hard and flat ſtone, upon which the matter is to be put, and bruiſed by another hard ſtone, ſo ſmall as to be held and moved upon the larger ſtone with the hand. The larger ſtone is called a *porphyry*, from its being generally of that kind of ſtone; and the operation is called *porphyriſation*. Inſtead of porphyriſation, a mill may be uſed, compoſed of a hard grit millſtone, moving round upon another ſtone of the ſame kind, which muſt be fixed: in the upper ſtone is a groove, or channel, through which the matter to be ground paſſes. By this method a ſubſtance may be more quickly reduced to a fine powder than by porphyriſation. But theſe mills can be only employed for conſiderable quantities of matter, as for manufactories of pottery and porcelain.

Theſe methods of mechanically dividing bodies are attended with ſome practical inconveniences; the moſt conſiderable of which is, that ſome parts of the dividing inſtruments are always ſtruck off, and mixed with the matter to be divided. This may greatly affect the operations. For inſtance, inſtruments of iron and copper furniſh coloring metallic parts, and the latter metal is hurtful to health. Porphyry is colored by a reddiſh-brown matter, which injures the color of cryſtal-glaſſes, enamels, and porcelain, made with matters ground upon this ſtone. Theſe matters, therefore, muſt be cleanſed after their porphyriſation, or elſe no inſtruments ought to be employed capable of injuring the intended operations. Thus, for the preparation of all medicines to be taken internally, no copper inſtruments, as mortars, peſtles, ought to be uſed; thoſe made of iron are preferable; and, inſtead of porphyries,

porphyries; mortars, grinding-ſtones, and mill-ſtones, made of hard and white ſtones, ought to be employed for ſubſtances which are to enter into the compoſition of enamels, cryſtal-glaſs, and porcelain, the whiteneſs of which is a moſt neceſſary quality.

DOCIMASTIC ART. This name is given to the art of eſſaying, by operations in ſmall, the nature and quantity of metallic or other matters, which may be obtained from mineral or other compound bodies. The moſt important operations of the docimaſtic art are found under the words, REFINING, ORES, ESSAYS *of* ORES.

DOME. The upper piece of furnaces, and particularly of portable furnaces, is called the *dome*. It has the form of a hollow ſemiſphere or ſmall dome. Its uſe is to form a ſpace in the upper part of the furnace, the air of which is continually expelled by the fire; hence the current of air is conſiderably encreaſed, which is obliged to enter by the aſh-hole, and to paſs through the fire, to ſupply the place of the air driven from the dome. The form of this piece renders it proper to reflect or reverberate a part of the flame upon the matters which are in the furnace, which has occaſioned this kind of furnace to be called a *reverberatory furnace*. *See* FURNACE.

DORONICUM. *(r)*

DRAGON's BLOOD. *(s)*

DUCTILITY. Ductility is a property poſſeſſed by certain ſolid bodies, which conſiſts in their yielding to percuſſion, preſſure, and in receiving different forms, without breaking.

(r) DORONICUM. From two ounces of the dry root were obtained by water fourteen drams of extract; and from the ſame quantity, with ſpirit, four drams and a half. This root is ſuppoſed by ſome to be poiſonous, eſpecially when freſh. *Neuman.*

(s) DRAGONS's BLOOD is a red-colored, inodorous, and inſipid reſin, unſoluble in water, ſoluble in ſpirit of wine and in oils, to both which liquors it communicates a red color. By fire it is fuſible, inflammable, and it emits an acid vapor like that of benzoin. A ſolution of dragon's blood in ſpirit of wine is uſed for ſtaining marble, to which it gives a red tinge, which penetrates more or leſs deeply according to the heat of the marble during application. But as it ſpreads at the ſame time that it ſinks deep; for fine deſigns, the marble ſhould be cold. Mr. Du Fay ſays, that by adding pitch to this ſolution, the color may be rendered deeper.

This property is nothing elſe than a continued adheſion of the integrant parts of thoſe bodies which have this property, although theſe parts change place reſpectively to each other. A body, therefore, cannot be ductile, excepting its integrant parts be ſo diſpoſed, that, while ſome of its contiguous parts are forced to ſeparate, others apply themſelves, ſo that the whole ſhall be ſtill one continued ſubſtance.

The figure of the integrant parts of ductile bodies contributes alſo probably to their ductility: but as we have not any certain knowledge of the form of the integrant parts of any body, we cannot explain ductility more preciſely and particularly.

Some bodies are ductile both when they are hot and when they are cold, and in all circumſtances. Such are metals, and particularly gold and ſilver. Other bodies are ductile only when they have a certain degree of heat; ſuch as wax, and ſubſtances of the ſame kind, and glaſs. *(t)* The degrees of heat requiſite to render theſe bodies ductile vary according to their different natures. In general, the heat muſt be ſuch as to be in a middle ſtate betwixt ſolidity and perfect fuſion or fluidity. As wax, for inſtance, is fuſible with a very ſmall heat, it may be rendered ductile by a ſtill ſmaller heat; and glaſs, which requires a moſt violent heat to be perfectly fuſed, cannot acquire its greateſt ductility without being made red-hot and almoſt ready to fuſe. Laſtly, ſome bodies are rendered ductile by the interpoſition of the parts of a fluid. Such are certain earths, and particularly clays. When theſe earths have abſorbed a ſufficient quantity of water to bring them into a middle ſtate betwixt liquidity and ſolidity, that is, to the conſiſtence of a conſiderably firm paſte, they have then acquired their greateſt ductility. Water has preciſely the ſame effect upon them in this reſpect as fire has upon the other bodies mentioned.

DULCIFICATION. When cauſtic and corroſive bodies are rendered milder by being combined with another ſubſtance, they are ſaid to be *dulcified*. This term is moſt commonly applied to the effect produced upon mineral acids

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(t) Laſtly, other bodies, as ſome kinds of iron, namely, thoſe called by workmen *red-ſhort*, braſs, and ſome other metallic allays, are ductile only when cold, and are brittle when hot. Concerning the ductility of metals, *ſee* METALS.

by their union with ſpirit of wine. *See* SPIRITS *of* NITRE, *of* SALT, *and of* VITRIOL (DULCIFIED).

DYING. The art of dying conſiſts in extracting from various ſubſtances coloring particles, and applying them to ſtuffs or other matters intended to be dyed, ſo that they ſhall adhere as firmly and durably as poſſible. *(u)*

Although

(u) DYING. Notwithſtanding the labors of Meſſrs. Hellot, Aſtruc, Du Fay, Juſſieu, and of ſome other authors, by which many proceſſes for dying are aſcertained; and notwithſtanding the attempts of Mr. Hellot to explain theſe proceſſes, yet the theory of dying is far from being known or eſtabliſhed. We do not ſufficiently underſtand the nature of the colorific particles of dying ſubſtances; nor the action of the ſalts and other matters uſed in moſt of the proceſſes for durable dyes; nor the cauſes of the differences of the ſeveral ſtuffs made of wool, ſilk, cotton, or thread, with regard to their aptitude to receive certain dyes. Many experiments are required to elucidate theſe ſubjects.

Before we mention Mr. Hellot's Theory of Dying, we muſt obſerve, that dyers enumerate five colors which they call primary, from the mixtures of which the other colors are produced. Theſe are blue, red, yellow, nut-color, and black. *Good dyes* are thoſe which can reſiſt the action of water, air, and of certain ſaline and ſaponaceous liquors which are uſed as proofs of the durability of colors. *Falſe dyes* are thoſe which cannot reſiſt theſe proofs. We may eaſily conceive the action of falſe dyes; that a colored decoction ſhould color any ſtuff dipped into it by the adheſion of part of it to the ſtuff; and that when the ſtuff has become dry by the evaporation of the water of the decoction, it may again be deprived, by waſhing with water, of the coloring ſubſtance; which being ſoluble, as it was originally, in water, may eaſily be waſhed out of the dyed ſtuff. But the action of thoſe dyes which, although once diſſolved or ſuſpended in water, cannot again, after they are applied to ſtuffs, be waſhed out, is not ſo eaſily underſtood. We ſhall here treat only of this latter ſort, or good and durable dyes. Dyes of different colors require different treatment. Stuffs to be dyed of a *red* or *yellow* color muſt be boiled in water with alum and tartar before they are dipped into the dying decoctions: the red coloring materials are *kermes*, *cochineal*, *gum-lac*, and *madder*; the yellow materials are *luteola*, or *dyers weed*, and other *yellow flowers*. The ſtuffs for *blue* dyes require no previous preparation. Theſe blue dyes are made of *indigo*, or the blue fecula obtained from *woad (ſee* INDIGO *and* WOAD), diſſolved in a lixivium of fixed alkali, or in urine, with or without the addition of ſome green vitriol. The ſtuffs intended to receive a *root color* require no previous preparation but to

DYING

Although the principles of all the mechanical arts have a ſingular dependance on chemiſtry, as we have endeavoured

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to be ſoaked in warm water. Theſe dyes are chiefly decoctions of *wallnut-ſhells*, *wallnut-roots*, *alder-bark*, *ſumach* and *ſaunders*. To theſe no ſaline or other matter is added. The *black* dyes, which are *inks*, or decoctions of *galls*, mixed with *green vitriol*, require no previous preparation of the ſtuff.

Mr. Hellot's Theory of Dying is, that the coloring particles are fixed into the pores of ſtuffs chiefly by means of a vitriolated tartar, which he believes to exiſt in each proceſs, to be produced by the acid of alum and alkaline baſis of tartar in the proceſs for red and yellow dyes, to exiſt originally in the pot-aſh employed in the blue dye, and in the nuts and roots employed in the root-colored dye. He ſuppoſes that the pores of the ſtuff are cleanſed and enlarged by the preparatory ſalts, and by the boiling water, ſo as to receive the coloring particles, which particles are afterwards detained by the contraction of the pores occaſioned by cold; and further, that theſe pores are lined with a ſaline cruſt of vitriolated tartar, or of tartar; which ſalts being difficulty ſoluble in water, retain firmly the coloring particles. But this theory cannot be admitted, when we conſider that vitriolated tartar does not exiſt in any of the materials uſed in ſome of the proceſſes for dying, as in the root-colored materials, from which no vitriolated tartar can be obtained, unleſs accidentally, till they have been by burning reduced to aſhes, and even then the quantity is exceedingly ſmall; that although common pot-aſh generally contains ſome vitriolated tartar, yet Mr. Hellot has not ſhewn that pure fixed alkali is incapable of producing the ſame effect; and laſtly, that vitriolated tartar and tartar, although they require much water to be diſſolved, are yet ſoluble by water; and therefore if the coloring particles were fixed chiefly by means of theſe ſalts, they might be waſhed out by a large quantity of water; which we find to be contrary to experience.

We ſhall find it more difficult to ſubſtitute a true theory, than to refute that of Mr. Hellot. Many experiments ought to be previouſly made. Nevertheleſs, it may be obſerved, that the colorific particles of moſt ſubſtances uſed in dying ſeem to be unſoluble in water, in ſpirit of wine, and even in alkaline lixiviums; that their diffuſion through theſe liquids is cauſed merely by their adheſion to certain gummy and reſinous particles; and that they may be diſengaged from thoſe gummy and reſinous matters, by applying a piece of ſtuff, to which they have a greater adheſive power; and this ſeems to be the caſe of the root-colored and blue dyes; or by applying another ſubſtance, to which theſe particles have a greater power of adheſion; ſuch as the earth of alum, in thoſe dyes where that ſalt is uſed together with ſome other ſubſtance,

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to ſhew in many parts of this work, few of them are ſo intimately related to this ſcience as the art of dying, all the operations of which are ſo many chemical operations. Theſe operations muſt be deſcribed at full length to ſhew all their relations to chemiſtry; but theſe details would lead us too far from our object. We muſt confine ourſelves to ſhew the moſt general principles of dying. Theſe have been already explained in a preliminary diſcourſe to the *Art of Dying Silk*, which is one of the diſſertations upon the arts publiſhed by the Royal Academy of Sciences. We ſhall here only make an extract of what is ſaid there, to oblige thoſe readers who have not that collection.

Moſt vegetable and many animal ſubſtances contain coloring principles which may be extracted and applied to other bodies: but theſe coloring principles are not always nearly of the ſame nature, and in the ſame ſtate; and theſe differences require that different methods ſhould be employed for the extraction and application of them.

Some of theſe coloring particles reſide partly in a ſaponaceous extractive ſubſtance, and partly in an earthy and reſinous

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as fixed or volatile alkali, capable of decompoſing alum; or as the ferruginous earth of the green vitriol in black dyes, to which the colorific particles of the galls adhere; which earths are capable of applying themſelves, and of adhering to the ſtuffs. The ſeparation of the coloring particles from the gummy and reſinous matters is probably facilitated by the addition of acids and neutral ſalts, which may coagulate in ſome meaſure the vegetable matters, and leave the colorific particles diſengaged; ſo that they may apply themſelves to the ſtuff, or to the above-mentioned earths. Theſe ſalts are alſo uſeful by heightening certain colors; all acid ſalts and alum having the property of heightening the red colors of vegetables. The metallic ſalt uſed in the *ſcarlet* dye (which conſiſts of a decoction of *cochineal*, to which a ſolution of tin in aqua-regia, and ſome tartar are added) has the effect of changing the crimſon color of cochineal to a vivid ſcarlet; and probably has alſo the other effects of alum, of affording an earth, namely that of tin, to which the coloring particles may adhere, and of coagulating the vegetable matters, ſo that they ſhall leave the coloring particles detached and ſuſpended in the water. The chief difference then betwixt the falſe and true dyes is, that the coloring particles in the former dyes are applied to ſtuffs, together with ſome gummy or reſinous matter to which they adhere, and are therefore liable to be waſhed out along with theſe matters by any liquid capable of diſſolving gums or reſins; while the coloring particles of the true dyes are applied to ſtuffs, either alone, reſinous matter. When ſubſtances, the colorific particles of which are in this ſtate, are boiled in water, they impregnate the water with their color; becauſe a part of the reſinous earthy portion is mixed and diffuſed in the water by means of the ſaponaceous extractive principle. If a ſtuff be plunged in a decoction of ſuch ſubſtances, the coloring particles are thereby made to touch and apply themſelves to it, and even to adhere firmly; becauſe the reſinous earthy coloring principle, when once united to the ſtuff, and ſeparated from the extractive principle, is no longer ſoluble either by water, ſoap, ſalts, or other active matters. Several ſubſtances are known, the coloring principles of which are in this ſtate. Of theſe the chief are the *green ſhells of wallnuts*, the *root* of the *wallnut-tree*, *ſumach*, *ſaunders*, *bark of alder*, and the ſhell-fiſh called *murex*, ſuppoſed to be the purple dye of the ancients. Excepting this latter ſubſtance, which gives a fine red, all the reſt give a dun color, called a *root-color*, but which is valuable notwithſtanding its little luſtre; becauſe it is very uſeful as a ground upon which other brighter colors may be applied. From the nature of theſe coloring ingredients we may perceive that no preparation is neceſſary for the colors, or for the matters to be dyed. They furniſh the ſimpleſt and

alone, or adhering to ſome fine earth, as the earth of alum or of tin; and as both the coloring and the earthy particles are unſoluble in any liquids, to which they are moſt apt to be expoſed, as water, ſoap-ſuds, &c. they are capable of reſiſting the action of theſe liquids, and are therefore durable. To confirm the above conjectures it may be obſerved, that when the coloring particles of vegetables and animals are diffuſed in an alkaline lixivium, by means of gummy, reſinous, or oily matters to which they adhere, they may be ſeparated from theſe adheſive matters by adding alum, the acid of which unites with the alkali of the lixivium; while the coloring particles apply themſelves to the baſis or earth of the alum, now diſengaged, with which they form what are called by painters *lakes*, the coloring matter of which is not now ſoluble in water or in ſpirit of wine; although theſe liquids are capable of extracting that coloring matter from the vegetable and animal ſubſtances which contain it, by the intervention, as is above ſuppoſed, of ſome gummy or reſinous matters.

For further particulars concerning dying, and the chemical hiſtory of dying ſubſtances, *ſee* BLACK, BLUE, CRIMSON, &c. *and* COCHINEAL, INDIGO, FLOWERS, FRUIT, LEAVES, &c. The *details* of the particular proceſſes in this art are deſcribed fully by *Mr. Hellot*, in his Treatiſes on the *Art of Dying*.

moſt practicable kind of dying; for all the operation conſiſts in boiling the dying materials in water, and in dipping the ſtuff to be dyed in this decoction.

The coloring principle of another kind of ſubſtance is contained in a matter altogether reſinous, which is ſo diſpoſed that it cannot be rendered miſcible with water by means of the ſaponaceous extractive principle of the ſame ſubſtance. The principal ingredients of this kind are *indigo*, which furniſhes the blue dye, and the flowers of *cartamus*, or *baſtard Saffron*, from which a very beautiful red is procured. Pure water cannot extract the colors from theſe matters. The blue reſinous part of indigo is alſo of the nature of thoſe which ſpirit of wine cannot diſſolve: but as fixed alkaline ſalts are capable of acting upon all reſinous matters, they are uſed ſucceſsfully to extract the coloring parts of theſe ingredients, and to render them fit for dying.

The coloring principles of almoſt all the other vegetable and animal matters which furniſh colors for dying, and which are very numerous, are of a purely extractive ſaponaceous nature, and may conſequently be eaſily extracted by water alone; but as they are ſoluble in water, they might eaſily be waſhed away from the ſtuffs to which they have been applied, if theſe ſtuffs had not previouſly been impregnated with ſome matter capable of producing ſome change or decompoſition on the coloring part.

A method has been found of fixing colors upon ſtuffs by different ſalts, with which the ſtuffs are impregnated before they are dyed. The extractive coloring particles are ſo changed by theſe ſalts, that they loſe their property of being ſoluble in water, and are even rendered capable of reſiſting the action of ſoap, and other ſubſtances which are apt to deſtroy moſt colors, and are therefore uſed to prove the durability of theſe.

Of all the ſalts which may be employed for this purpoſe, *alum* is found to be the fitteſt: it is therefore generally employed for all extractive tinctures, which are very numerous, the principal of which are *luteola*, or *dyer's-weed*, and all the herbs which give a yellow color, *madder*, *vegetable kermes*, *cochenil*, *Braſil-wood*, *log-wood*, and other woods and roots uſed in dying. Alum is not the only ſalt which has this effect. All neutral ſalts with metallic baſes are alſo capable of fixing the extractive colors: but ſome of theſe are very dear, and others change and ſpoil the colors; ſo that alum is ſolely employed for this purpoſe.

All theſe dyes cannot be equally well fixed by alum, or by the other ſalts above-mentioned. Some of them are only ſo much fixed by alum as to reſiſt the action of water, but not of the other ſubſtances uſed to prove the fixity of colors, nor even of the air, during a long time. This latter kind of dyes are called *falſe* or *ſmall tints*, to diſtinguiſh them from the more fixed dyes, called *great* or *good tints*.

Theſe differences muſt proceed from the particular nature of each of the coloring materials: but very accurate analyſes of theſe materials, and a great number of new reſearches muſt be made, before this obſcure ſubject can be explained. It will even appear ſtill more obſcure, when we conſider that the different nature of the ſubſtances to which the dye is applied, ſurprizingly effects the beauty and fixity of colors. For inſtance, the red color of madder, which is ſufficiently beautiful and fixed upon wool and cotton, gives but a falſe tint upon thread; alſo cochenil, which gives a vivid and bright flame-colored red to wool, and even to moſt animal matters, does not adhere to ſilk, cotton, or thread. In the particular details of the proceſſes for dying the different kinds of matters many other ſingular differences may be found, which require particular attention to be explained. The moſt general inference from theſe particular details is, that wool and all animal matters are the moſt eaſily dyed; next to them, ſilk and other ſubſtances, which ſeem to be intermediate betwixt the animal and the vegetable nature; and laſt of all, thread, and vegetable matters.

The few facts and general principles we have advanced on the art of dying are ſufficient to ſhew its connexion with chemiſtry, and how much it may be improved by this ſcience.

EARTHS. Earth is one of the four ſimple ſubſtances called elements, or primitive principles; becauſe they are indeed the moſt ſimple of all thoſe which enter into the combination of compound bodies. We cannot doubt, in particular, that the greateſt part of the compounds which we can analyſe contain earth as one of their principles; for after art has exhauſted all its efforts to decompoſe them, a fixed and ſolid matter always remains, upon which no change can be produced; and this is what is generally called earth. It has the ſolidity, weight, fixity, and other principal properties of the maſs of ſolid matter which forms the globe we inhabit, called alſo *the earth.*

Theſe general conſiderations are ſufficient to convince us, that in nature a ſubſtance exiſts whoſe properties are different from thoſe of fire, air, water; and which is, like theſe other ſubſtances, one of the elements of compound bodies. But a vague aſſertion like this does not ſatisfy chemiſts. Beſides the aſcertaining of the exiſtence of the different ſubſtances ſubmitted to their examination, they require to know the properties of theſe ſubſtances in their greateſt degree of purity and ſimplicity: but they have found much difficulty and uncertainty in inveſtigating the eſſential properties of the pureſt and ſimpleſt terreſtrial element.

Earth is not found ſo pure as the other elements, fire, air, and water, which, though not entirely free from mixture, are however ſo pure, that we may certainly and eaſily diſcover their fundamental properties. Theſe properties of each of theſe pure elements are ſo well aſcertained, and ſo evident, that nobody has yet attempted to diſtinguiſh different kinds of fire, air, or water, notwithſtanding the differences which may ariſe from the heterogeneous ſubſtances with which they are almoſt always mixed.

But we cannot ſay the ſame of earth; for a conſiderable number of ſubſtances are called earths, becauſe they poſſeſs the principal properties of the terreſtrial element: but theſe ſubſtances, when examined more particularly, are always found to differ from each other ſo much in other reſpects, and to be ſo difficultly purifiable from heterogeneous matter, that we have not aſcertained whether only one ſimple and elementary earth, or ſeveral ones eſſentially different, although equally ſimple, exiſt.

The moſt general and moſt probable opinion is, that as only one kind of fire, of air, and of water, ſo only one kind of ſimple elementary earth, exiſts. Alchemiſts chiefly have endeavoured to diſcover this primary earth, not with an intention to aſcertain its properties, but becauſe they imagined that as gold is the pureſt of metals, the earth of which it is partly compoſed muſt be alſo the moſt pure; they have, therefore, ſearched every where for this earth, which they call *pure earth* and *virgin earth.* They have endeavoured to obtain it from dew, rain, the air, aſhes of vegetables, animals, and ſeveral minerals: but it was impoſſible to find it in compound bodies; for we ſhall ſee that when once this element makes part of a compound body, it cannot be diſengaged from the ſubſtances with which it has united.

Some of the beſt philoſophical chemiſts have rather choſe to admit different kinds of elementary earths, than to inveſtigate the nature of the moſt ſimple and elementary of all. Becker admits three principles, which he calls *earths*, namely, *the vitrifiable*, *the inflammable*, and *the mercurial earth*, which are known by the name of *the three earths of Becker*.

Mr. Pott, examining the principal natural earths, divides them into four kinds, *the vitrifiable*, *the calcareous*, *the argillaceous*, and *the gypſeous earths*. This able chemiſts ſhew the eſſential propetties of theſe four kinds of earths, without affirming that they are all equally ſimple, and without even determining which of them he conſidered as moſt ſimple.

As earth is an element which enters into the compoſition of almoſt all bodies, and which ſeems chiefly to effect their properties, it deſerves an accurate inveſtigation to diſcover which is the moſt ſimple and elementary of all the ſubſtances to which the name *earth* has been applied. This ſubject ſeems capable of deciſion by conſidering, firſt, what are the eſſential properties by which earthy ſubſtances differ from other elements, and then by determining that earth to be the moſt pure and ſimple, which poſſeſſes theſe properties moſt eminently and deciſively; for we cannot doubt, that the properties diſtinguiſhing earthy matters from the other elements are the eſſential and ſpecific characters of the earthy element; and alſo, that the more eminently any ſubſtance poſſeſſes theſe charactiſtic properties of the earthy element, the nearer it approaches to this element, conſidered in its ſtate of purity and ſimplicity.

This being eſtabliſhed, if we compare with the other elements all the ſubſtances which may reaſonably be conſidered as earthy, we ſhall ſoon be convinced, that theſe poſſeſs much greater *weight*, *hardneſs*, *fixity*, and *infuſibility*, than any other element; for theſe qualities are inſenſible, or do not exiſt, in the element of fire; they are in an exceedingly ſmall degree in the air, and are more ſenſible and conſiderable in water; but are infinitely leſs than in any thing which can be conſidered as earth. Hence we ought to conclude, that the qualities above-mentioned are the diſtinguiſhing and characteriſtic eſſential properties of the earthy element. But theſe qualities are not ſo eminently united in any of thoſe ſubſtances which are conſidered as earthy, as in that which is called by chemiſts, *vitrifiable earth*. We ſay then, that this earth is the heavieſt, hardeſt, moſt fixed, and moſt infuſible, and even the moſt *apyrous* of all earths, when it is very pure; and alſo that it is the moſt homogeneous, the moſt ſimple, and elementary earth, as we ſhall prove by a more particular examination of its properties, and by a compariſon of theſe with the properties of the other earthy ſubſtances.

We call that *vitrifiable earth*, the integrant parts of which when united form maſſes of matter or ſtones, abſolutely white and colorleſs, much more tranſparent and hard than any other natural ſubſtances, and which ſuffers no alteration, or even fuſion, by the ſtrongeſt fire which we can apply to it.

Amongſt the hard ſtones called vitrifiable, we indeed know few which ſtrictly poſſeſs all the qualities we have mentioned; becauſe in very few of them the vitrifiable earth is pure. Moſt of theſe ſtones, as hard pebbles of all kinds, ſand, free-ſtone, agates, quartz, rock-cryſtal, and the ſtones called precious, are deficient in ſome of the qualities required to conſtitute the pureſt vitrifiable earth. Some of them are opake, or only ſemitranſparent; others are colored; ſome are fuſible by a great heat; and, laſtly, others, although much harder than any other kind of ſtones, want the laſt degree of hardneſs; all which prove that they are mixed with heterogeneous ſubſtances, chiefly phlogiſtic, metallic, or even earthy, of a different kind.

The pureſt of all the vitrifiable ſtones is the diamond, which is perfectly white, free from all color or ſtain, and tranſparent. This ſtone is alſo known to be the hardeſt of all, is abſolutely apyrous, that is, incapable of receiving any alteration by the moſt violent heat. We, therefore, conſider the matter of this ſtone as the pureſt, ſimpleſt, and moſt elementary earth that is known. The properties, then, of this ſtone, and of the other vitrifiable ſtones which reſemble it, may give us notions of the properties of primary, elementary, unchanged earth. In this our opinion is conformable to that of the illuſtrious Stahl, who indeed admits the three earths of Becker; but, at the ſame time, corrects the theory of this chemiſt, by declaring that he only conſiders the firſt earth of Becker, or vitrifiable earth, as the proper terreſtrial or earthy element. *Specimen Beckerianum*, p. 44. No. 25.

But before we particularly enumerate the properties of this earth, we ought to make ſome obſervations on thoſe hard, earthy, and ſtoney matters called by chemiſts *vitrifiable.*

Our firſt obſervation ſhall be concerning the name *vitrifiable earth*; becauſe it may produce falſe notions of the nature of theſe ſtones.

We ſay then, that the epithet, *vitrifiable*, is given, firſt, becauſe ſome ſtones of this kind are, by means of their heterogeneous matters, capable of fuſion and converſion into glaſs, without addition, and merely by the action of a very violent heat; and ſecondly, becauſe other ſtones of this kind, which are leſs fuſible than theſe now mentioned, but which are yet more ſo than ſtones of other kinds, require for their perfect fuſion and vitrification a leſs quantity of flux, and a leſs degree of heat.

In the ſecond place, as all the earths and ſtones called vitrifiable have, notwithſtanding their impurity, more hardneſs and tranſparency than others, and are fitter to communicate theſe good qualities to glaſs, they are employed preferably to any other earths in the compoſition of glaſs, or artificial cryſtal. Theſe are the only reaſons why this kind of earth has been called vitrifiable. But we ought not from thence to conclude, that the earthy ſubſtance which almoſt entirely compoſes them is more fuſible and more vitrifiable than other earths: on the contrary, I again ſay, that vitrifiable earth, when very pure, is of all earths the leaſt fuſible, and the leaſt vitrifiable. I was preſent at a fine experiment made relatively to this ſubject. Some diamond powder was mixed with a ſufficient quantity of fixed alkali to vitrify another earthy matter, and the mixture expoſed to a heat ſufficient for the moſt difficult vitrifications. After the operation, no glaſs was found in the crucible; but part of the alkali had been diſſipated by the violence of the heat, and the diamond powder did not ſhew any ſigns of a beginning fuſion. Thus we may conſider it as an eſtabliſhed truth, that the earths and ſtones called vitrifiable are not eſſentially and really ſo; that the fuſibility of ſome of theſe, by which property they are rendered the fitteſt earths for vitrification, proceeds from heterogeneous matter with which they are mixed: and that, in general, the whiteſt, cleareſt, moſt tranſparent and hardeſt of theſe ſtones are alſo the moſt refractory and unfuſible. *See* VITRIFICATION.

Our ſecond obſervation ſhall relate to the weight of vitrifiable earths. We have already ſaid, that the pureſt and ſimpleſt of all earths ought to be alſo the heavieſt; and accordingly we find that pure vitrifiable earth is ſpecifically heavier than calcareous, argillaceous, gypſeous, or other earths. We are, nevertheleſs, no leſs certain, that metals, metallic earths, and ſeveral kinds of ſpars, both calcareous and ſelenitic, are much heavier than the moſt compact vitrifiable ſtones; but we muſt conſider that theſe earthy matters are very compound bodies in compariſon of the purer earths. An objection may be made, that if elementary earth be eſſentially the heavieſt of all matters, then any body compounded of this earth and other matters ought to be lighter than pure earth. This objection would be unanſwerable, if the ſpecific gravity of a body was always equal to the ſpecific gravities of the integrant and conſtituent parts which compoſe it: but as theſe parts may be ſo arranged that void ſpaces may be left betwixt them, ſometimes larger, and ſometimes leſs, therefore a body compoſed of parts eſſentially lighter, may yet have a greater ſpecific gravity than another body whoſe parts are eſſentially heavier; and this happens in all metals and metallic matters. *See* METALS *and* METALLISATION. Thus the gravity of metals and of metallic earths and ſtones ought not to prevent our conſidering the pure and elementary earthy principle as the heavieſt of all natural ſubſtances.

After theſe explanations, we may conſider the properties of elementary earth in the pureſt vitrifiable ſtones, and may compare them with the properties of the other elements. Since of theſe elements water is the moſt capable of our examination, we ſhall compare it with the pureſt vitrifiable earth; obſerving always, that we conſider theſe elements in their ſtate of aggregation; for we have no method by which their primary integrant parts can be known and conſidered ſeparately.

If then, on one ſide, we conſider a maſs of water, abſolutely pure, expoſed to a cold ſufficient to form it into hard, compact, ſolid ice; and if, on the other ſide we compare to this a maſs of vitrifiable earth, as a diamond, or even a very fine and clear rock-cryſtal, we ſhall eaſily perceive that theſe two matters reſemble perfectly each other in their appearance; we ſhall find that both of them are colorleſs, inodorous, and taſteleſs; and that their tranſparency is alike: therefore, if we could no further examine their properties, we muſt conſider them as being of the ſame matter; but when the other properties of theſe ſubſtances are examined, as weight, hardneſs, fuſibility, and fixity, then we ſhall perceive differences, which indeed are only in the degrees of theſe properties poſſeſſed by each of the two ſubſtances; but the difference of theſe degrees is very great. Thus the ſpecific gravity of rock-cryſtal is almoſt four times that of ice; their hardneſs alſo is ſo different, that the earthy ſubſtance reſiſts the point of the hardeſt ſteel, without being ſcratched; and when ſtruck by ſteel, elicits ignited ſparks; while ice may be eaſily cut by inſtruments of ſteel, and does not elicit ſparks when ſtruck: their difference of fuſibility is ſtill more ſenſible, the ice becoming fluid by a gentle warmth, which does not ſenſibly affect rock-cryſtal in any reſpect. I ſay, *ſenſibly*; becauſe with the leaſt diminution of cold it is certainly ſomewhat affected, ſo far as to be expanded, and conſequently to be leſs hard and heavy. But theſe two latter affections, particularly, are ſo inconſiderable in a vitrifiable ſtone with the heat neceſſary to thaw ice, that probably it cannot be eſtimated. Laſtly, if we continue to examine theſe two ſubſtances by a heat gradually augmented, we ſhall ſee the water totally diſſipated in vapors, before even either of theſe ſubſtances has become red-hot, and the vitrifiable ſtone ſupport a heat almoſt infinitely encreaſed, till it is white and dazzling, without becoming fluid, or without any part of it exhaling in vapors; for it may be afterwards found to have loſt no weight by having been expoſed to this heat.

So far we can extend our examination; for I do not believe that a pure vitrifiable earth, as a diamond, can be fuſed even in the focus of the beſt burning ſpeculums: but ſuppoſing that a ſufficient heat might be produced to procure this fuſion, or that this ſtone were expoſed to infinitely greater heat, ſuch as we conceive to be in the body of the ſun, it would then melt, and would even be reduced to vapors, if the heat were ſufficiently violent; and when this heat ſhould ceaſe, it would, when it cooled, fix again, and become ſuch a ſubſtance as it was before. The ſame would happen to vitrifiable earth in theſe circumſtances, which does happen to water rendered fluid, and reduced to vapor by a certain heat, and which is again frozen into ſolid ice when that heat is removed. The differences, therefore, betwixt theſe two ſubſtances are only, as we have already ſaid, in the degrees; but alſo theſe differences are very conſiderable.

From theſe conſiderations an inference ſeems deducible, that the elements or the ſimpleſt ſubſtances which we know are eſſentially only one and the ſame matter, and only differ ſrom each other in the quantity and in the form of their primary integrant molecules, which, from this difference of form and quantity, have a greater or leſs tendency to unite together; and we might be inclined to believe that a certain kind of analogy or gradation exiſts betwixt them: thus, for example, that earth ſhould be to water, what water is to air, and what air is to fire, or rather to ſome unknown intermediate ſubſtances betwixt air and fire; for the difference betwixt theſe two latter elements appears too great to be compared with the differences amongſt the three former. But theſe are ſpeculations entirely ſyſtematic; for we are very far from being capable of eſtimating the eſſential properties of elements ſufficiently exact, to be able to determine any thing preciſely and poſitively in this reſpect.

However that may be, we cannot doubt but that earth chiefly differs from the other elements by the powerful tendency which its parts have to each other, and by the force of their coheſion. For its hardneſs, fuſibility, fixity, and even its gravity, are evidently the neceſſary conſequences of this principal and eſſential property. And by this property does the earthy element act in the ſyſtem of nature. By this it is the cauſe of the conſiſtence of all ſolid bodies. It receives, fixes, and incorporates in ſome meaſure the other elements.

Laſtly, as without fire the whole world would be one maſs of ſolid and immoveable matter, ſo without earth it would be a confuſed heap of fogs, vapors, a chaos of incoherent atoms, deſtitute of that harmony and equilibrium which ſuſtain it.

We have already had occaſion to ſhew, in ſeveral parts of this work, that the general tendency of the parts of matter to each other is the grand ſpring of the univerſe; that by this power, all combinations, ſolutions, and, in a word, all the movements and operations of nature are performed: and as we have ſhewn that the earthy element poſſeſſes this tendency in the greateſt degree, we ought to conſider earth as being in this ſenſe the moſt active and powerful of all elements. This notion is contrary to the opinions of chemiſts and philoſophers, who from not having ſufficiently examined this ſubject, and being deceived by the ſeeming inactivity of earth conſidered in its ſtate of aggregation, have affirmed it to be an element purely paſſive, and only capable of impulſe from other elements. Indeed when the parts of earth are united together, they appear to be, and really are, incapable of acting upon other bodies, becauſe they then exhauſt all their action mutually upon each other. But the force with which they adhere together, and which renders them incapable of forming other unions, the extreme hardneſs, and the inſolubility of a maſs of pure earth, ought to demonſtrate to a true philoſopher, that if we ſuppoſe the parts of earth ſo ſeparated from each other, that they cannot unite, and exhauſt their action upon each other, they muſt then poſſeſs all their force of tendency, which muſt be very great, they muſt be in a ſtate of violent effort, and conſequently muſt tend with extreme force to unite with any parts of matter which may be within their reach, and to which they can apply themſelves. We do not indeed know any pure earth which is in this ſtate of broken aggregation: but we know compounds in which the primitive integrant parts of the earthy element are only combined with the parts of water, which are incapable of ſatisfying all their tendency to union. Theſe are the moſt ſimple ſaline ſubſtances, ſuch as acids and alkalis; and we may judge by the force and vehemence of the action of theſe ſolvents, how violent the action of the parts of earth would be, which ſhould be capable of exerting all the attractive force which belongs to them.

Although the entire maſs of our globe be probably formed by an immenſe heap of elementary, vitrifiable, and even actually vitrified earth, as the illuſtrious Buffon believes, we do not find upon its ſurface but a very ſmall quantity of this earth, unaltered, and in its primary ſtate. Perhaps even none of it exiſts in that ſtate: for, as we have obſerved, the common vitrifiable ſtones, which are chiefly formed of it, are very far from the degree of purity of primary elementary earth; and even perfect diamonds, which ſeem of all theſe ſtones to approach the neareſt to this purity, ſeem to have been elaborated by the waters, if we can judge from their regularly cryſtallized form.

We ſhall not be ſurprized at the ſcarcity of pure earthy element, if we conſider that the ſurface of the earth, which alone we are acquainted with, has been from the beginning of the world expoſed to the conſtant action of the other elements; and that by uninterrupted operations, nature, aſſiſted by fire, air, and water, has gradually diſunited the integrant parts of elementary earth, and by combining them in manners and proportions infinitely various with parts of the other elements, has formed the numberleſs compound bodies, which occupy a certain thickneſs near the circumference ſerence of the globe, probably very ſmall in compariſon of the diameter of the earth, but very large with regard to us, whoſe greateſt efforts only extend to a few hundred feet below its ſurface.

All the portions of elementary earth, which, having been thus diſunited, have afterwards been combined with parts of matter of other kinds, have received very ſenſible changes, the effects of which always remain, and prevent them from appearing afterwards, notwithſtanding future decompoſitions, in their original purity and ſimplicity. They then aſſume different forms according to the nature of the compounds into the combination of which they have entered. Thus, for example, the earth which makes parts of the cruſtaceous animals, or rather of their ſhells and ſcales, takes the character of that earth which is called *calcareous*, and which is capable of converſion into quicklime by the action of fire. The earth which has entered into the compoſition of plants, and even of the bodies of animals, after having been deprived as much as is poſſible of the principles of theſe compounds to which it was united, forms all the *argillaceous earths*. Some of theſe are found which partake both of the calcareous and of the argillaceous properties, and are called *marles*. Marles have not yet been ſufficiently well examined by chemiſts. They are either a mixture of clay and calcareous earth, or they have been ſo elaborated by nature as to be transformed into a particular earth, partly calcareous, and partly argillaceous, ſuch as the earth of animal bones ſeems to be.

As the earth which forms ſands and the common impure vitrifiable ſtones retains more than the reſt the eſſential properties of elementary earth, notwithſtanding the heterogeneous, phlogiſtic, and other parts with which it is mixed; we cannot eaſily know whether it has once made a part of ſome very compound bodies, from the principles of which it has been more perfectly ſeparated than the argillaceous and calcareous earths; or whether it be the primitive earth, which, without having made part of any intimate combination, has only been divided and conveyed by waters, and the parts of which have afterwards reunited, having only contracted a ſlight union with ſome phlogiſtic, metallic, and other matters, with which it is found mixed. This latter ſuppoſition appears to me to be the moſt probable. But very extenſive reſearches in natural hiſtory and in chemiſtry are requiſite to determined this queſtion.

From what we have ſaid concerning the principal kinds of earths which form the ſurface of the globe, we may conclude, that excepting the pureſt vitrifiable earth, all the others are mixed with heterogeneous matter. By theſe remaining heterogeneous matters are the different kinds of earth ſpecified and characteriſed: and as they all preſerve and retain their peculiar character, we ought to conclude from thence, that theſe extraneous matters are very intimately united. To purify and ſimplify theſe mixed earths, ſo that they ſhall be aſſimilated to the pureſt vitrifiable earth, would be a fine problem. But, probably, this problem is beyond the power of our art. For as, in general, the perfect ſeparation of two ſubſtances, united together, is exceedingly difficult, this difficulty muſt greatly increaſe, when one of the two ſubſtances to be ſeparated has a very ſtrong attractive power, as earth has. This is the true reaſon why we find ſo ſmall a portion of pure earth amongſt the bodies within our reach; and that on the contrary, the globe is covered with ſo great a quantity of earthy ſubſtances differing from each other ſo much, that we might be inclined to believe them to be bodies eſſentially different. *See the articles*, EARTH (CALCAREOUS), EARTH (VITRIFIABLE). *(x)*

EARTH

(x) In this article the author has advanced ſome ingenious ſpeculations, but in my opinion ſeveral of his propoſitions are affirmed without proof, and ſome of his inferences are not concluſive. The ſubject does not appear to me capable of being treated ſo deciſively. Moſt philoſophers, ancient and modern, have enumerated, according to their theories, the *elements* of which they believed all ſubſtances to be conſtituted. Nevertheleſs, they have not yet proved the exiſtence of any one element. The impoſſibility even of ſuch a proof appears from conſidering, that the only reaſon which can induce us to believe any ſubſtance to be an element, is, that we are incapable of decompoſing that ſubſtance; and that our incapacity to decompoſe does not neceſſarily imply an impoſſibility of decompoſition. For if we ſhould call every ſubſtance an *element* that we cannot analyſe, (and thus we might ſpeak preciſely concerning *elements*) then certainly many other ſubſtances beſides fire, air, water, and earth, might be enumerated as elements. According to this meaning the number of elements will decreaſe, when means of decompoſing ſome of thoſe which cannot now be decompoſed are diſcovered. The author believes that only one kind of elementary earth exiſts, and he further believes that this earth is that which he

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EARTH (ANIMAL). *(y)*

EARTH (ARGILLACEOUS). *See* CLAY.

EARTH

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and ſome other authors call *vitrifiable*. But beſides that the claſs of earths called vitrifiable contains many ſubſtances, the properties of which are exceedingly different, no proof can be given that thoſe ſubſtances, which are believed to be the pureſt of this claſs of earths, as diamonds, are more ſimple and elementary than calcined calcareous earths, argillaceous earths, earth of magneſia, metallic or many other earths; all which, when purified by ordinary methods, are as incapable of decompoſition as diamonds are, and conſequently as well entitled to be conſidered as elementary.

Earths are divided by Mr. Pott into vitrifiable, argillaceous, calcareous, and gypſeous. The author of the Dictionary follows this diviſion. Other authors have invented other diviſions, and enlarge the number of claſſes, by which their diſpoſitions are more comprehenſive and diſtinct.

But although theſe arbitrary arrangements of natural ſubſtances may aſſiſt the memory of learners, yet as they are all very imperfect, our knowledge will be alſo very imperfect, unleſs we conſider ſeparately each ſpecies. In the notes to this Dictionary, therefore, the chemical properties of each ſpecies, as well as of the general and claſſes of earths, (in which are comprehended, not only ſubſtances, commonly called earths, but alſo ſtones, ſlates, ſpars, and talks) ſhall be mentioned as the names of theſe ſpecies occur in the alphabetical order.

(y) EARTH (ANIMAL) is the earth of ſhells of animals; or that which is obtained by calcination, or putrefaction of animal ſubſtances. 1. The *earths of the ſhells of Sea Fiſhes* have the general properties of calcareous earths. *See* EARTHS (CALCAREOUS). It is ſaid to differ from the mineral calcareous earths in being more difficultly ſoluble by vitriolic acid, and in being leſs diſpoſed to vitrify along with ſalts and metallic glaſſes. The *ſhells of eggs* are alſo calcareous, but are ſomewhat fuſible by fire. 2. The *earths of calcined bones and horns* are ſoluble by nitrous, marine, and vegetable acids, and with difficulty by vitriolic acid; but are not capable of being converted into quicklime by calcination. They are ſaid to be unfuſible, even when mixed with ſalt, metallic glaſſes, and other fuſible mixtures. They are therefore uſed in the compoſition of enamels and opake white glaſſes. Nevertheleſs, Wallerius affirms, that the earth of calcined bones, by intenſe heat, was changed, without addition, to a green glaſs. *See Mem. Sued.* 1760. The ſame author ſays, that the earth of the whites and yolks of eggs was eaſily fuſible, and that in general the fuſibility of animal earths is in proportion to the ſoftneſs of the

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EARTH (CALCAREOUS). Chemiſts have given this name in general to all earths and ſtones, which being burnt acquire the properties of quicklime.

Nature preſents to us a conſiderable quantity of calcareous earths and ſtones, which have peculiar differences depending on their greater or leſs purity, but which reſemble each other by eſſential properties common to all, and particularly by their capacity to receive calcination.

The principal kinds of theſe earths or ſtones are, chalks, all the calcinable ſhell-ſtones employed for building, all marbles, calcinable ſtalactites, the alabaſters and ſpars which are convertible into quicklime by fire.

Amongſt theſe ſtones a great number are evidently impure and mixed, particularly thoſe which are colored. But amongſt the whiteſt, we cannot eaſily aſcertain which of them contains the pureſt earth, becauſe they have not been chemically compared with this view. We ought certainly to conſider thoſe as the pureſt which poſſeſs in the higheſt degree the eſſential properties of calcareous earth.

All calcareous ſtones are leſs hard than vitrifiable ſtones; none of them ſtrike fire with ſteel, and they all may be eaſily cut with ſteel inſtruments; ſome of them may be found, whoſe parts having been divided, conveyed by waters, and afterwards depoſited ſucceſſively upon each other, form concretions, or rather cryſtallizations, very neat and even tranſparent. Their tranſparency however is always leſs than that of the purer vitrifiable ſtones.

The ſpecific gravity of the different kinds of calcareous ſtones has not been compared with the ſpecific gravity of the vitrifiable. We only know that ſome calcareous ſpars are much heavier than the precious ſtones, and are therefore called *heavy ſpars*. But as we are very certain that the weight of theſe bodies is cauſed by extraneous and not calcareous matter, this does not prevent our eſtabliſhing a general rule that calcareous earth is leſs heavy

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the parts from which they were obtained. 3. The *earth of blood, fleſh, and ſkins* of animals, is ſoluble by all acids, and is fuſible by fire; that of blood and of other animal fluids being moſt fuſible. This earth, like that of burnt bones and horns, is not calcareous; but both theſe kinds of earth are ſaid to be rendered calcareous by being diſſolved in acids, precipitated by fixed alkali from thoſe acids, and afterwards calcined. They probably contain ſome mucilaginous ſubſtance, from which they cannot be entirely diveſted by fire without a previous ſolution in acids.

than vitrifiable; for, excepting the inſtance now mentioned, they all are ſo.

If any calcareous earth or ſtone be divided by trituration and moiſtened with water, it abſorbs a certain quantity of it, particularly if it be very dry; and it forms a kind of paſte, the parts of which have a certain adheſion together. But this paſte is not ſo ductile as that formed by clay and water. It alſo dries and diſunites much more quickly.

All acids are evidently capable of acting upon calcareous earth; they attack and diſſolve it with more or leſs effervescence. This action of acids upon calcareous earths and ſtones furniſhes us with an eaſy method of diſtinguiſhing them from other earthy and ſtony matters, which they reſemble externally.

Calcareous earth ſaturates all acids, and forms with them different *neutral ſalts with baſes of calcareous earth*, according to the kind of acid.

With vitriolic acid, it forms a cryſtallizable ſalt, not very ſoluble in water, called *Selenites*.

With nitrous and marine acids, it forms acrid, bitter, and very deliqueſcent ſalts. They are called *nitre*, and *marine ſalts, with calcareous baſes*.

With the acid of vinegar, calcareous earth forms a ſalt not deliqueſcent, and ſuſceptible of a ſilky and ramoſe cryſtallization like a kind of vegetation. This is *acetous ſalt with calcareous baſis*.

Laſtly, with acid of tartar, this earth forms a neutral cryſtallizable ſalt, a *ſoluble tartar with calcareous baſis*. This ſalt is much more ſoluble in water than pure acid of tartar.

Calcareous earth has alſo the property of decompoſing all ammoniacal ſalts, from which it diſengages the volatile alkali, and unites with their acids, when aſſiſted by a certain heat.

Calcareous earths and ſtones, being expoſed to the action of fire, loſe part of their weight, and much of their conſiſtence, which proceeds from the fire carrying off a conſiderable quantity of water that enters into their combination; and as the laſt portions of water are powerfully retained by earth, a very ſtrong heat is requiſite to diſſipate them; and in this principally conſiſts the change produced upon calcareous ſtones when reduced into quicklime. *See* QUICKLIME.

The moſt violent fire we can make is incapable of melting and vitrifying calcareous earths and ſtones, when they are very pure *(z)*; but a very remarkable thing is, that theſe ſubſtances, ſo refractory when alone, become true fluxes, and facilitate the fuſion and vitrification of ſeveral other ſubſtances, as ſands and clays. This phenomenon, the cauſe of which is hidden, and not eaſily to be diſcovered, ſeems to depend on a particular diſpoſition of the inflammable principle from which none of theſe matters is entirely exempt, and perhaps on ſome remaining portion of watery principle, ſo ſtrongly retained by calcareous earth, that fire cannot entirely extricate it. *See* VITRIFICATION.

The other characteriſtic properties of calcareous earth are the ſame as the properties of this earth when converted into quicklime, which we ſhall relate and explain under the article QUICKLIME. We ſhall only here obſerve, that if we add to theſe the properties of calcareous earth before calcination, we ſhall evidently ſee that all theſe properties, and the phenomena ariſing from them, depend on the intimate union of a certain quantity of watery principle with the earthy principle in calcareous earth; an union which produces an incipient ſaline combination, according to Stahl's theory, and a ſtrong diſpoſition in calcareous earth to paſs into a more compleat ſaline ſtate by a more perfect combination with water. We may hence eaſily perceive, that as calcareous ſtones in their natural ſtate do not differ from vitrifiable ſtones but in being leſs hard, leſs heavy, and leſs fixed, which are preciſely the eſſential qualities by which pure water differs from pure earth; that as the action of the fire deprives calcareous ſtones of much water, calcareous earth chiefly differs from vitrifiable earth by its union with water; and laſtly, that as we cannot doubt but that all calcareous earth has been once one of the principles of organiſed animal bodies, we cannot alſo doubt, but that the water, the portion of phlogiſton *(a)*, perhaps alſo ſome remaining ſmall

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(z) Mr. D'Arcet found that chalk, lime-ſtone, and one calcareous ſpar, reſiſted a violent, long continued heat; but that other ſpars, ſtalactites, and other calcareous ſubſtances, ſhewed a beginning fuſion. *See Mem. l' Acad. des Sc. ſur l' Action d'un feu violent, egal, & continué,* 1766.

(a) Moſt, perhaps all calcareous earths contain ſuch a portion of phlogiſton, as to enable them, by means of heat, to reduce metallic calxes, eſpecially thoſe of lead and biſmuth, which are eaſily

ſmall part of ſaline matter, which are found in theſe earths, and which diſtinguiſh their different kinds, are the remains of the principles with which the elementary earth was found combined in theſe compounds, and which continue firmly united with them. *(b)*

EARTH (GYPSEOUS). This name is applied by ſome chemiſts to gypſum, and to the earth contained in ſelenites. As the earth of gypſum, when ſeparated from the vitriolic acid, does not appear to be different from pure

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eaſily reducible, and even in ſome meaſure thoſe of copper and iron. By means alſo of this phlogiſton they acquire a phoſphoric quality when united with nitrous acid. *See* Phosphorus *of* Baldwin. A curious experiment is mentioned by Mr. Pott, which ſhewed this phoſphoric quality of calcareous earth united with nitrous acid. He ſaturated that acid with quicklime, and diſtilled it. He repeated this operation frequently, always uſing the ſame acid and the ſame quicklime. He perceived that the vapors which paſſed in theſe diſtillations through a hole in the receiver appeared luminous ſparks, which afterwards kindled, and flowed out like a ſtream of fire. He alſo perceived another remarkable circumſtance in this operation, namely, that the efferveſcence which happened on the mixing theſe two ſubſtances, became each time greater than it had been in the preceding expepiment. Whence did the quicklime acquire the gas which cauſed theſe efferveſcences? Was it from the acid? *See* Pott's *Diſſertation on Quicklime.*

(b) Calcareous earths may be combined with acids, with which they form neutralized earthy ſalts. *See* Salts. They alſo readily unite with fixable air, in which ſtate of combination they are always found native. When uncombined with gas, or in the ſtate of quicklime, they may be combined with water, forming lime-water. *See* Water (Lime), Gas, Cream *of* Lime, *and* Quicklime. In this uncombined ſtate they alſo may be united in ſome degree with ſulphur, forming a kind of hepar of ſulphur, and imperfectly with oleaginous ſubſtances forming kinds of ſoaps.

Calcareous earth, although infuſible by fire (*ſee the above note* (z), may be rendered fuſible and vitreſcible by addition of fixed alkaline ſalt, of borax, of ſedative ſalt, of ſalt of urine, of metallic calxes, of gypſeous and argillaceous earths, of fuſible ſpars, and according to Mr. Pott, of ſparry quartz, of glaſs-gall, and of fixed ammoniac. Mr. Gellert, in his Table of Solutions, places calcareous earth amongſt the ſubſtances incapable of uniting with gypſeous earths. Neverthelеſs, the experiments of Mr. Brandt and of Mr. D'Arcet evince the fuſibility of calcareous earths mixed with gypſum.

calcareous earth, we refer to the articles GYPSUM, SELENITES, *and* EARTH (CALCAREOUS).

EARTH (MERCURIAL). Mercurial earth is a ſubſtance, which, according to Beecher and other chemiſts, enters into the compoſition of many bodies, particularly the metallic, together with *vitrifiable earth*, and phlogiſton, which that chemiſt calls the *inflammable earth*. But the exiſtence of this mercurial earth has not yet been ſatisfactorily demonſtrated. Metals and marine acid, of which alſo Beecher ſuppoſes the mercurial earth to be a conſtituent part, do indeed preſent ſome phenomena which may induce us to ſuſpect that theſe ſubſtances contain a principle different from all thoſe which we know. But theſe phenomena are not ſufficient to eſtabliſh with certainty the exiſtence of this principle. *See what is ſaid on this ſubject under the articles* ACID (MARINE), MERCURIFICATION, METALS, *and* METALLISATION.

EARTH (VEGETABLE). *(c)*

(c) EARTH (VEGETABLE). From numerous experiments made by Wallerius, we find that earths or aſhes of vegetables have not all the ſame chemical properties, but may be reduced into three kinds or claſſes. The firſt claſs is the earth obtained by burning ſoft, ſpongy, and farinaceous plants. It is partly ſoluble by vitriolic acids. It is more fuſible by fire, in proportion as the plant from which it has been obtained was more nouriſhing. Thus the aſhes of rye, barley, oats, muſtard, and eſpecially thoſe of wheat and rice, were eaſily fuſible, forming green tranſparent glaſſes. This fuſion is not occaſioned by any mixture of alkaline ſalt, for no ſuch ſalt could be obtained from the aſhes of the above-mentioned grains by lixiviation. The ſecond claſs of vegetable earths is produced by burning the harder and leſs ſucculent plants. This earth is more ſoluble than the former in nitrous and marine acids, but is leſs ſoluble in vitriolic acid. This earth, after lixiviation, ſtill abſorbs moiſture from the air. It is alſo fuſible by fire, but not ſo eaſily as the former earth, and is leſs fuſible in proportion to the hardneſs of the plant. The third claſs of vegetable earth is that which is obtained by burning wood. This earth is calcareous, and is more difficultly fuſible in proportion as the wood from which it was obtained was harder. Accordingly, it has been obſerved by manufacturers of glaſs, that aſhes of the hardeſt woods make the moſt unfuſible glaſs. Garden mould, which conſiſts chiefly of the earth of decayed vegetables, was alſo found to be fuſible by fire. *See the Swediſh Memoirs for the year* 1760. By putrefaction of vegetable ſubſtances, a calcareous earth is ſaid to be obtainable.

EARTH (VITRIFIABLE). The earth ſo called by chemiſts is the pureſt, ſimpleſt, and moſt elementary of all known earths. As we have mentioned all the eſſential properties of this earth under the general article Earth, we refer for theſe properties to that article. We ſhall only obſerve here, that the ſtones formed principally by the union of the parts of this earth, and therefore called vitrifiable ſtones, are eaſily diſtinguiſhed from all the others by their hardneſs, which is ſo great, that they cannot be cut by ſteel tools, and that they can elicit ſparks from ſteel. They have alſo the property of giving ſparks of light when one of them is ſtruck againſt another; but it is then an internal fire, and ignited ſparks are not emitted, as when they are ſtruck by ſteel. This property of giving light by percuſſion alſo belongs to glaſs, porcelain, and other vitrified matters. It ſeems to be a phenomenon depending on electricity.

Vitrifiable earth, when pulveriſed into very fine parts, and moiſtened with watar, abſorbs but a very ſmall quantity of this liquid, and forms a paſte which has conſiderable adheſion, but no ductility. When it is made thin by water, it pours like an oily or viſcid matter: when it is of a thick conſiſtence, it does not preſerve the form given to it, but it ſinks and collapſes: it alſo dries very quickly and eaſily. If, on the contrary, this finely ground vitrifiable matter be left at reſt under water, its parts will unite and adhere together ſo ſtrongly, that a maſs ſhall be formed almoſt as hard as a ſtone. Hence when vitrifiable ſtones are ground with water, the matter muſt be continually agitated and ſtirred, and the mill muſt be turned without interruption; for if they are left but a little at reſt, they harden, and adhere ſo ſtrongly to the bottom of the mill, that the mill-ſtone cannot without difficulty be again ſet in motion. This inconvenience may be much diminiſhed by mixing the vitrifiable earth to be ground, with different earths, calcareous or argillaceous.

No vitrifiable ſtone or earth is ſoluble in any acid, unleſs its nature has been changed by having been intimately united with ſome other ſubſtance; as, for inſtance, by fuſion with a ſufficient quantity of fixed alkali: but it cannot then be conſidered as pure vitrifiable earth, as it has not then the properties of that earth.

As ſome ſtones externally reſemble vitrifiable ſtones, and which alſo reſiſt the action of acids, although they are not vitrifiable, the proof by acids is not ſufficient to aſcertain the nature of theſe ſtones. To this proof muſt alſo be added that of hardneſs, which is the moſt deciſive. Many impure and mixed vitrifiable earths and ſtones differ from each other by their colors, and other accidental particulars depending on the heterogeneous matters with which they are united.

Nature preſents to us many mixed earths and ſtones, or ſuch as are compoſed of many kinds of different earths, as the vitrifiable, calcareous, talky, argillaceous, gypſeous or ſelenitic, and even the pyritous or metallic. But we cannot enter into theſe details, which are the object of mineralogy. We ſhall obſerve, that when an accurate examination of theſe compound bodies is required, the nature and proportions of the component parts may be diſcovered by ſubmitting them ſucceſſively to the deciſive proofs which we have mentioned under the articles of the principal kinds of earths and ſtones, by which their nature may be diſcovered and aſcertained. *See in particular for the vitrifiable earths and ſtones, the general article* EARTH, *and the word* VITRIFICATION.

EARTH-WORMS. *(d)*

EAU DE LUCE. Eau de luce is a kind of volatile, liquid ſoap, of a ſtrong, penetrating ſmell.

This liquor is compoſed of the liquid volatile alkali made from ſal ammoniac with quicklime, and of the rectified oil of amber, ſo mixed together as to produce a white milky liquor.

Eau de luce cannot be prepared without certain management; for if the volatile ſpirit of ſal ammoniac and rectified oil of amber be ſimply mixed and ſhook together, a milky

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(d) EARTH-WORMS. Earth-worms, when moiſtened with wine, or with vinous ſpirits, to prevent their putrefaction, and ſet in a cellar in a wide mouthed veſſel, are in a few days almoſt wholly reſolved into a ſlimy liquor. Stahl ſuppoſes that they are impregnated with a nitrous ſalt which they receive from the putrid matters amongſt which they live. When this liquamen of worms is mixed with a little fixed alkali, and, after the evaporation, is ſet to ſhoot, the cryſtals are nothing elſe than nitre. Six drams of extract were obtained by ardent ſpirit from four ounces of worms; and from the ſame quantity of theſe, one ounce, ſix drams, and a ſcruple of extract, by means of water. Thirty-two ounces of dried earth-worms yielded, by diſtillation, thirteen ounces and a half of volatile urinous ſpirit, one ounce of concrete volatile ſalt, four ounces and a half of empyreumatic oil, and eight ounces of a reſiduum, from which were obtained, by calcination and lixiviation, an ounce and a half of fixed alkali. *Neuman.*

liquor will be produced, ſuch as is required; but this color diſappears ſoon when the liquor is allowed to reſt; either becauſe the volatile alkali compleatly diſſolves the oil of amber when in ſmall quantity, or becauſe this oil diſengages itſelf from the volatile alkali, and floats apart when in conſiderable quantity. In both caſes the liquor becomes clear and tranſparent; but the milkly color is required in eau de luce. By the following receipt excellent eau de luce may be made.

Take four ounces of rectified ſpirit of wine, and in it diſſolve ten or twelve grains of white ſoap; filtrate this ſolution; then diſſolve in it a dram of rectified oil of amber, and filtrate again; mix as much of this ſolution with the ſtrongeſt volatile ſpirit of ſal ammoniac, in a cryſtal-glaſs bottle, as when ſufficiently ſhook, ſhall produce a beautiful milky liquor. If upon its ſurface be formed a cream, ſome more of the oily ſpirit of wine ought to be added.

This receipt is given by the author of the French edition of the London Diſpenſatory. The receipt given in that work is very good, but is much improved by the obſervations, experiments, and remarks made by that author.

EDULCORATION. Edulcoration is, properly ſpeaking, the rendering ſubſtances more mild. Chemical edulcoration conſiſts almoſt always in taking acids and other ſaline matters from ſubſtances to which they adhere; and this is effected by waſhing in much water. The waſhing of diaphoretic antimony, and of the powder of algaroth, till the water comes off from theſe ſubſtances quite pure, may be given as inſtances of edulcoration.

In Pharmacy, juleps, potions, and other medicines, are ſaid to be *edulcorated*, by adding ſugar or ſyrup.

EFFERVESCENCE. Effervеſcence is an inteſtine motion excited betwixt the parts of two bodies of different natures, when they reciprocally diſſolve each other. Effervеſcences are commonly accompanied with bubbles, vapors, ſmall jets of the liquid, and noiſe or hiſſing. All theſe phenomena are occaſioned by the air which diſengages itſelf in almoſt all ſolutions. Frequently alſo effervеſcences are accompanied with a conſiderable heat, ſometimes exceeding that of boiling water. This heat is occaſioned by the colliſion of the parts during their union. The degree of heat produced in effervеſcences is proportionable to the activity with which bodies are diſſolved, to the quickneſs with which the ſolution is made, and to the quantity of ſubſtances re-acting upon each other.

The moſt ſenſible effervеſcences are obſerved in the combination of concentrated mineral acids with calcareous earths, alkaline ſalts, metallic ſubſtances, and oily matters.

Generally the ſubſtances which contain a ſenſible quantity of inflammable principle are thoſe which in ſimilar circumſtances produce the moſt heat in effervеſcing with acids. Of all acids, the nitrous produces the greateſt heat, when it diſſolves theſe bodies.

Thus, for inſtance, the heat ariſing from a ſolution of calcareous earth in nitrous acid is not nearly ſo great as that which ariſes from a ſolution of a metallic ſubſtance in the ſame acid, although theſe ſolutions are performed equally faſt; and the heat which is produced by the combination of nitrous acid with oils is ſo great, that a flame is quickly produced.

Formerly the word *fermentation* was commonly applied to effervеſcences; but now that word is confined to the motion which is naturally excited in animal and vegetable matters, and from which new combinations amongſt their principles take place. This diſtinction is very proper; for a ſimple effervеſcence is very different from a true fermentation. *See* FERMENTATION.

EFFLORESCENCE. By this expreſſion chemiſts denote what happens to certain bodies, upon the ſurface of which a kind of meal or powder is formed.

Efflorеſcence is occaſioned either by decompoſition or by drying. That which happens to Cobalt, and moſt martial pyrites, is of the former kind; and the efflorеſcence obſerved on cryſtals of marine alkali, of Glauber's ſalt, of alum, of green and blue vitriols, and of ſeveral other ſalts, is of the latter kind.

EGGS. The eggs of hens, of birds in general, and of ſeveral other animals, are compoſed of ſeveral diſtinct ſubſtances; 1. Of a ſhell or external coat, which in the eggs of birds has a certain hardneſs and conſiſtence, although it is brittle. The matter of this ſhell is a fine, abſorbent earth, ſoluble in acids; hence if theſe eggs be ſteeped in vinegar, or any other acid, they are rendered quite ſoft, becauſe the acid diſſolves and takes away all the earth of their ſhells. (e)

(e) The ſhells of eggs are not only abſorbent, that is, ſoluble by acids, but alſo calcareous, or convertible into quicklime. The earth of the ſhells, and alſo the earth obtained by calcination of the other parts of the eggs, are fuſible and vitreſcible by fire *See* EARTH (ANIMAL).

EGGS

The parts of this earth are bound together by a ſmall quantity of gelatinous matter. This matter becomes very ſenſible by an empyreumatic animal ſmell, and by the black color which ſhells acquire when expoſed to fire.

The ſhell of an egg is lined internally with a very white, fine, and ſtrong membrane. It reſembles a very fine ſkin, and is entirely of animal nature.

Theſe external coverings contain the ſubſtance of the egg, which is of two kinds; namely, a lymphatic, white, tranſparent, gelatinous, viſcous, and gluey ſubſtance, called *the white of the egg*; and another ſubſtance alſo gelatinous, but almoſt opake, yellow, leſs gluey and viſcous than the white. This latter, which is called *the yolk*, is of a ſpherical form, and is ſurrounded by the white. To the yolk is annexed a ſmall portion of white gelatinous matter, thicker and tougher than the reſt of the white in which the embryo is contained.

We do not intend here to examine anatomically the uſes of theſe ſeveral parts of the egg; we will conſider them only relatively to their chemical properties and principles. As eggs contain the embryo of the animal, and the nouriſhment proper for it in its firſt increaſe, they are proper to be given as an example of the analyſis of animal feed.

The white of an egg cannot be diſſolved by acids or by ſpirit of wine. This latter ſolvent, far from dividing it, on the contrary coagulates it, by taking from it a great part of its water which renders it liquid.

The white of an egg is ſoluble and miſcible with water, but difficultly, becauſe of its viſcidity. Spirit of wine poured into water which keeps it diſſolved ſeparates it, and precipitates it in form of a curd. In this reſpect, the white of an egg reſembles gummy, mucilaginous, and gelatinous matters. It is, in fact, a matter entirely of the nature of animal jellies, but of that kind which is coagulable by heat. The white of an egg, expoſed to a leſs heat than that of boiling water, is coagulated, hardened, and its tranſparency is almoſt entirely changed to a milky-white color. This ſubſtance contains no other principles which are volatile with the heat of boiling water, than water; for if whites of eggs be diſtilled in a water-bath, nothing but water is obtained. While they loſe this water, they become more and more hard and horny; they reſume their tranſparency, and acquire a yellow-reddiſh color; ſo that when they are dried as much as poſſible, they perfectly reſemble horn.

If they are to be further analyſed, they muſt be put into a retort, and expoſed to a naked fire: then fetid empyreumatic oil with much volatile alkali is obtained; and in the retort, when the diſtillation is finiſhed, a coal is left like that of other animal matters. From this analyſis we ſee that the white of an egg is a perfectly animaliſed ſubſtance. *See* JELLY (ANIMAL).

The yolk of an egg is chiefly compoſed of a gelatinous matter like the white; for it alſo coagulates and hardens by heat; but it alſo contains a conſiderable quantity of mild fat oil, which is in ſome meaſure ſuperabundant, and not combined, and, in ſhort, in the ſame ſtate as thoſe oils which may be obtained from vegetable emulſive ſeeds by expreſſion. Thus the raw yolk of an egg when mixed with water is not entirely diſſolved, as the white is; but forms with it, on account of this oily part, a white milky liquor or emulſion. This animal emulſion is vulgarly called *hen's milk*.

This ſuperabundant oil of the yolk of an egg may be ſeparated from it, like that of moſt vegetable grains, by expreſſion. But to make this operation ſucceſsful, the yolk of an egg ought to be deprived as much as is poſſible of its water. For this purpoſe, the eggs are to be previouſly hardened, and the yolks are to be ſeparated, dried, and even roaſted in a proper veſſel, till they become ſomewhat ſoftened by the ſweating out of the oil; they are then to be put into a preſs, and a fat, unctuous, yellowiſh, and ſufficiently mild oil is procured, which readily fixes itſelf in the cold. This oil has the ſmell of roaſted or fried eggs, from the drying and roaſting given to the yolks before the expreſſion. Probably this oil might be obtained by a ſlower and more careful drying without roaſting, and conſequently without any change or ſmell.

From this quantity of ſuperabundant oil in yolks of eggs, we may perceive a remarkable reſemblance betwixt the eggs of animals and vegetable ſeeds. This oil is found in all ſeminal matters probably for the ſame reaſon. *See* OILS (SWEET EXPRESSED).

As all eggs in general are compoſed of a very nouriſhing ſubſtance, and as thoſe of many animals have a very agreeable taſte, they have been much uſed as aliment. They are alſo employed in medicine and in the arts. The white of an egg is an ingredient in collyriums and cataplaſms for diſeaſes of the eyes; and both the white and yolk in emollient and reſolvent cataplaſms. The oil of eggs is ſoftening, relaxing, and lubricating. It is employed either ſingly, or formed into a pomatum with fat matters, in burns, chaps, contractions, and other ſimilar diſeaſes.

The white of an egg, from its ſolubility in water, and from its coagulating by fire or in ſpirituous liquors, is very ſucceſsfully employed in pharmacy, in the kitchen, and for clarifying the juices of plants, whey, ſugar, ſyrups, &c. *See* FILTRATION.

The white of an egg alone forms a varniſh very white and very ſhining, which is applied to ſeveral kinds of work, and particularly to pictures. Laſtly, the yolk of an egg, from its oily and viſcid parts, is a proper intermediate ſubſtance for the mixture by trituration of oils with watery liquors, ſo as to form emulſions. Several good remarks are found upon this ſubject in Mr. Beaumé's Treatiſe on Pharmacy. *(f)*

ELECAMPANE. *(g)*

ELEMENTS. Thoſe bodies are called by chemiſts *elements*, which are ſo ſimple, that they cannot by any known method be decompoſed, or even altered; and which alſo enter as principles, or conſtituent parts, into the combination of other bodies, which are therefore called compound bodies.

The bodies in which this ſimplicity has been obſerved are fire, air, water, and the pureſt earth; for by the moſt complete and accurate analyſes which have been made, nothing has been ever ultimately produced but ſome one, or more, of theſe four ſubſtances, according to the nature of the decompoſed bodies.

Theſe ſubſtances, although reputed ſimple, may poſſibly not be ſo, and may even reſult from the union of ſeveral other more ſimple ſubſtances: but as experience teaches us nothing on this ſubject, we may without inconvenience,

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(f) Mr. Reaumur found that eggs might be preſerved during months or years, by being covered with mutton ſuet, or any other fat ſubſtance.

(g) ELECAMPANE. From thirty-two ounces of the roots of elecampane were obtained, by diſtillation, three ſcruples and a half of concrete oil, ſimilar in many, but not in all its properties to camphor. This concrete oil is ſoluble in ſpirit of wine. Geoffroy remarks, that it reſides in the exterior part of the root, near to the bark. From an ounce of the dry root ſix drams and a half of extract may be obtained by water, and from the ſame quantity two drams and a half by ſpirit. *Neuman.*

and we ought to conſider, in chemiſtry, fire, air, water, and earth, as ſimple bodies; becauſe they really act as ſuch in all chemical operations.

The elements are alſo called by chemiſts *primary principles.* *See* PRINCIPLES, FIRE, AIR, WATER, *and* EARTH.

ELIQUATION. *(h)*

ELUTRIATION. *(i)*

EMERALD. *(k)*

EMERY. *(l)*

(h) ELIQUATION. This is an operation by which a more fuſible ſubſtance is ſeparated from one leſs fuſible, by means of a heat ſufficiently intenſe to melt the former, but not the latter. Thus an allay of copper and lead may be ſeparated by applying a heat which ſhall melt the lead, but not the copper.

(i) ELUTRIATION is an operation performed by waſhing ſolid ſubſtances with water, ſtirring them well together, and haſtily pouring off the water, while the lighter part remains ſuſpended in the agitated water, that it may be thereby ſeparated from the heavier part. By this operation metallic ores are cleanſed from earth, ſtones, and other lighter unmetallic particles adhering to them.

(k) EMERALD, *Smaragdus*, is a precious ſtone, contained by ſeveral unequal ſides, forming irregular priſms. Its color is green: with a moderately ſtrong heat it becomes blue, but recovers its original green color when cold. By expoſure to collected ſolar heat, emeralds were rendered white and of various colors, and ſoon afterwards were fuſed, by which they loſt part of their weight and hardneſs. *See* DIAMONDS. But M. D'Arcet could not fuſe an Emerald in the intenſe and long continued heat of a porcelain furnace, although the color and tranſparency of the Emerald were thereby altered. Emeralds have the property of ſhining in the dark after having been heated. They are the fourth in hardneſs from diamonds; nevertheleſs they are ſuſceptible of impreſſion from a file. Emeralds may be imitated by adding forty-eight grains of pulveriſed calcined verdigriſe, and eight grains of martial crocus, to four ounces of minium and two ounces of pure ſand, and by keeping that mixture fuſed during twenty-four hours.

(l) EMERY. *Smiris.* Emery is a very refractory mineral containing a ſmall portion of iron. It is exceedingly hard, and is therefore uſed for the poliſhing of metals, glaſs, and hard ſtones. Some pieces of emery contain ſmall ſpecks of gold, and of copper. The mineral called by alchemiſts *ſmiris Hiſpanica*, and employed to adulterate gold, is with probability believed to be the metal now called platina.

EMPYREUMA. Empyreuma is a ſmell proceeding from burnt animal and vegetable matters, when they are expoſed to a quick fire, particularly in cloſe veſſels.

Empyreuma is the peculiar ſmell of burnt oils. No other but oily ſubſtances can produce it. As all vegetable and animal matters contain oil, and as no other ſubſtance contains it, hence the empyreumatic ſmell muſt be peculiar to burnt animal and vegetable matters; and hence alſo we may diſcover oil, wherever it may be, by this ſmell, which is ſo diſtinguiſhable, that it is very ſenſible even when the quantity of oil is too ſmall to be diſcovered by any other method. If then we perceive an empyreumatic ſmell when we burn a ſubſtance in cloſe veſſels, we may conclude that this ſubſtance contains oil. If, on the contrary, no empyreuma be perceived, we may be aſſured that the ſubſtance does not contain oil.

EMULSION. An emulſion is a watery liquor, in which ſome oily matter is diſperſed and diffuſed (but not diſſolved) by the intervention of a mucilaginous or gelatinous ſubſtance.

The ſtate of the oil in emulſions is the cauſe why they are opake, and of a milky-white color; for this milky appearance is given to all tranſparent bodies by others that have not a very diſtinct color, when they are mutually interpoſed and divided to a certain degree.

Nevertheleſs, water and oil ſlightly adhere together in emulſions, by the intervention of the mucilaginous matter; for oil agitated with water gives but a momentary appearance of an emulſion, and only during the agitation. When it is left to reſt, the oil preſently riſes to the ſurface.

All vegetable and animal ſubſtances contain an uncombined oil; and mucilage or jelly, being triturated with water, yield emulſions.

Moſt ſeeds and grains, all gum-reſins, gummy and reſinous juices, and yolks of eggs, are capable of forming emulſions with water. Laſtly, the milky juices of plants, milk, and the chyle of animals, ought to be conſidered as natural emulſions.

ENAMEL. Enamel is in general a vitrified matter, betwixt the parts of which is diſperſed ſome unvitrified matter: hence enamel ought to have all the properties of glaſs excepting tranſparency. Enamels then are opake glaſſes, and their opacity and colors proceed from the unvitrified matter which they contain. The unvitrified matters which give opacity and various colors to enamels, are almoſt always metallic calxes. Receipts for making ſeveral kinds of enamel may be found in ſeveral books, particularly in Neri's Treatiſe on the Art of Making Glaſs, with Notes by Merret and Kunkel.

Enamels ought to be very fuſible. They are employed to color or to paint ſeveral kinds of work which are made by great heat. The white enamel is uſed to cover the earthen ware called *Delf*, to which it gives the appearance of porcelain. With the other colored enamels this Delf-ware, porcelain, and alſo the white enamel, are painted. *See* DELF-WARE. *(m)*

(m) Enamels are glaſſes containing ſome opake ſubſtance, that is either unvitrifiable or incapable of being vitrified with the degree of heat requiſite for the fuſion of ordinary glaſs. Of the latter ſort are almoſt all the enamels uſed, they being moſtly compoſed of glaſs mixed with metallic calxes; all which, not excepting the calx of tin, by more intenſe heat might be reduced to tranſparent glaſſes. The white vitreous compoſition which is the baſis of all enamels is prepared, according to Neri, by melting together a hundred parts of frit of calcined flints, one part of pure ſalt of tartar, and a hundred parts of a calx of lead and tin. This calx is prepared by calcining together equal parts of tin and lead, and reducing the ſubſtance ſo calcined to a very fine powder, by bruiſing it, paſſing it through a ſieve, boiling it in water, decanting the water in which the finer parts are ſuſpended, evaporating the water, and drying the powder; and by repeating the calcination and ſubſequent operations upon the groſſer particles, till they become as fine as the former. This compoſition when ſlightly fuſed is to be reduced to a powder, and formed into all the various colored enamels, by adding to it coloring ſubſtances. Thus by adding to ſix pounds of this compoſition, forty-eight grains of magneſia, a *fine white enamel* may be prepared; an *azure blue enamel*, by adding to the ſame quantity three ounces of zaffre, and ſixty grains of calcined copper; a *turquois blue enamel*, by adding three ounces of calcined copper, ninety-ſix grains of zaffre, and forty-eight grains of magneſia; a *green enamel*, by adding three ounces of calcined copper and ſixty grains of ſcales of iron; a *ſhining black enamel*, by adding three ounces of zaffre and as much magneſia; a *purple enamel*, by adding three ounces of magneſia; a *yellow enamel*, by adding three ounces of tartar and ſeventy two grains of magneſia; a *ſea-green or beryl-colored enamel*, by adding three ounces of calcined braſs and ſixty grains of zaffre; and a *violet colored enamel*, by adding two ounces of magneſia and forty-eight grains of calcined copper. Theſe are

ENS MARTIS, *and* ENS VENERIS. Theſe Latin names are given to the flowers of iron and of copper made with ſal ammoniac, or rather to theſe two metals ſublimed by this ſalt. *See* FLOWERS.

ESSAY. Eſſays are chemical operations made in ſmall, to determine the quantity of metal or other matter which is contained in minerals, or to diſcover the value or purity of any maſs of gold or ſilver.

We ſhall treat ſucceſſively of each kind of eſſay.

ESSAY *of* ORES. Before eſſays of ores can be well made, a preliminary knowledge of the nature of the ſeveral metallic minerals ought to be attained. Each metal has its proper and improper ores, which have peculiar characters and appearances: hence perſons, accuſtomed to ſee them, know pretty nearly, by the appearance, weight, and other obvious qualities, what metal is contained in a mineral. A good eſſayer ought to be very intelligent in this matter, that he may at once know what the proper operations are which are requiſite to the eſſay of any given mineral. Some remarks may be found on this ſubject under the article ORES.

As metals are very unequally diſtributed in their ores, we ſhould be apt to make falſe and deceitful eſſays, if we did not uſe all poſſible precautions that the proportionable quantity of metal produced by any eſſay ſhall be nearly the medium contained in the whole ore. This is effected by taking pieces of the mineral from the ſeveral veins of the mine, if there be ſeveral, or from different places of the ſame vein. All theſe minerals are to be ſhook together with their matrixes. The whole is to be well mixed together, and a convenient quantity of this mixture is

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the receipts given by Neri, and approved by Kunkel. The intenſity and continuance of the heat muſt be attended to, as the colors both of enamels and of the tranſparent glaſſes imitating colored precious ſtones, eſpecially of thoſe which contain magneſia, depend much on theſe circumſtances. White enamels may be compoſed of other ſubſtances beſides calx of tin. Merret propoſes to ſubſtitute regulus of antimony. Calcined bones, and perhaps other white earths, may be uſed for the ſame purpoſe. Mr. D'Arcet found that gypſum mixed with white clay, or with clay and hard ſpar, formed very beautiful enamels, Perhaps ſome of theſe enamels would form glazings preferable to that made with calx of tin, for covering thoſe kinds of earthen ware which require, in the baking, greater heat than is ſuitable to the common enamel.

to be taken for the eſſay. This is called the *lotting* of the ore.

As eſſays, particulary the firſt, are generally made in ſmall, eſſayers have very ſmall weights correſponding to the weights uſed in the great, that is, to the quintal or hundred pounds weight, to pounds, ounces, drams, &c. The eſſay quintal and its ſubdiviſions vary according to the difference of weights in different countries, and this occaſions ſome confuſion, when theſe weights are to be adjuſted to each other. Tables of theſe weights are found in treatiſes of eſſaying, and particularly in that written by Schlutter, and tranſlated and rendered more complete by Hellot, which contains all the details neceſſary for the ſubject.

The cuſtom is to take, for the eſſay quintal, a real weight of a gros, or dram, which in France is equal to 72 grains; but as the whole dram repreſents 100 pounds, each grain repreſents a pound and a fraction of a pound; and hence ſome difficulty and confuſion ariſe in making the ſubdiviſions. A better method is that of Mr. Hellot, which is to make the fictitious or eſſay quintal equal to a hundred real grains, and then each grain repreſents a real pound. This eſſay quintal is ſufficiently exact for ores of lead, tin, copper, iron, antimony, biſmuth, and mercury. But for ores of ſilver and gold another repreſentation is convenient; for theſe metals, as Mr. Hellot ſays, are generally in ſo ſmall quantity, that the button or ſmall piece of metal obtained in the eſſay could not be accurately weighed, if a hundred real grains were made to repreſent a quintal; and the difficulty of ſeparating the gold from ſo ſmall a quantity would be ſtill greater. Theſe motives have induced Mr. Hellot to uſe for theſe ores a fictitious quintal ſixteen times greater, that is, equal to 1600 real grains, which repreſent 1600 ounces, that is, 100 lb. or quintal. The ounce being repreſented by a grain, its ſeveral ſubdiviſions muſt be repreſented by fractions of a grain. Thus 12 grains of the fictitious quintal correſpond with $\frac{5}{48}$ of a real grain (*n*); and this latter quantity may be accurately weighed in eſſay balances, which when well made, are ſenſible to a much leſs weight.

(*n*) The pounds, of which a hundred are here ſuppoſed to make a quintal, are called Paris pounds, one of which contains 9216 grains. *See* WEIGHTS.

When a quintal of an ore to be eſſayed has been weighed, and lotted, as we deſcribed above, it is to be roaſted in a teſt under a muffle. It is to be waſhed, if neceſſary; and, in ſhort, the ſame operations are to be made in ſmall which are uſually done in great. Additions alſo are to be made, and in proper proportions, according to the peculiar nature of the ore. The fluxes generally mixed with the ore in eſſays are three, four, or five parts of black flux; one, two, or three parts of calcined borax; and one half of that quantity of decrepitated common ſalt. The more refractory the ore is, the more neceſſary is the addition of theſe fluxes: then the whole mixture is to be fuſed either in a forge, or in a melting or eſſay furnace.

To make eſſays well, all poſſible attention and accuracy are to be employed. This object cannot be too much attended to; for the leaſt inaccuracy in weighing, or loſs of the ſmalleſt quantity of matter, might cauſe errors, ſo much greater, as the diſproportion betwixt the weights employed and thoſe repreſented is greater. The moſt minute accuracy therefore is neceſſary in theſe operations. For inſtance, the eſſay balances ought to be ſmall, and exceedingly juſt. The ore ought not to be weighed till it has been reduced to groſs powder fit for roaſting; becauſe ſome of it is always loſt in this pulverization. When the ore is roaſted, it ought to be covered with an inverted teſt; becauſe moſt ores are apt to crackle and diſperſe, when firſt heated. To make the fuſion good and compleat, the preciſe degree of fire which is requiſite ought to be employed; and when it is finiſhed, the crucible ought to be ſtruck two or three times with ſome inſtrument to facilitate the diſengagement of the parts of the regulus from the ſcoria, and to occaſion their deſcent and union into one button of metal. The crucible ought not to be broken, nor its contents examined till it is perfectly cold.

Upon breaking the crucible, we may know that the fuſion has been good, if the ſcoria be neat, compact, and equal; if it has not overflowed or penetrated the crucible; if it contain no metallic grains; and if its ſurface be ſmooth, and hollowed in the middle. The regulus or button ought to be well collected, without holes, or bubbles, and to have a neat convex ſurface: it is then to be ſeparated from the ſcoria, well ſcraped and cleaned; and, laſtly, is to be weighed. If the operation has been well made, its weight ſhows the quantity of metal which every real quintal of ore will yield in the great. If the perfect ſucceſs of this eſſay be in any reſpect doubtful, it ought to be repeated; but the beſt method at all times is to make ſeveral eſſays of the ſame ore. Some ſmall differences are always found, however well the eſſays may have been made. By taking the medium of the reſults of the ſeveral operations, we may approach, as nearly as poſſible, the true product of the ore.

Laſtly, as mines are not worked, nor founderies eſtabliſhed (which cannot be done without conſiderable expence) till the ore has been eſſayed, ten or twelve real pounds of the ore ought to be previouſly eſſayed; and eſſayers ought to be furniſhed with neceſſary furnaces and inſtruments for theſe larger eſſays.

We now proceed to give ſome examples of eſſays of ores. To eſſay a lead ore, for inſtance, which is not very refractory, let one or more quintals of this ore be groſly powdered, and roaſted in a teſt till no more ſulphureous vapors be exhaled, and then reduced to a finer powder; it is then to be accurately mixed with twice its weight of black flux, a fourth part of its weight of clean filings of iron and of borax. Theſe proportions are given by Mr. Cramer. The mixture is to be put into a good crucible, or rather into a teſt; it is then to be covered with a thickneſs of two or three fingers of decrepitated ſea-ſalt; the crucible is to be cloſed, and placed in a melting furnace, which is to be filled with unlighted charcoal, ſo that the top of the crucible ſhall be covered with it. Lighted coals are then to be thrown upon the unkindled charcoal, and the whole is left to kindle ſlowly, till the crucible be red-hot; ſoon after which a hiſſing noiſe proceeds from the crucible, which is occaſioned by the reduction of the lead: the ſame degree of fire is to be maintained while this noiſe continues; and is afterwards to be ſuddenly encreaſed, ſo as to make a perfect fuſion; in which ſtate it is to be continued during a quarter of an hour; after which it is to be extinguiſhed; and the operation is then finiſhed.

The filings of iron are added to the mixture, to abſorb the ſulphur, a certain quantity of which generally remains united with the lead ore, notwithſtanding the roaſting. We need not fear leſt this metal ſhould unite with the lead and alter its purity; becauſe although the ſulphur ſhould not hinder it, theſe two metals cannot be united. The refractory quality of the iron does not impede the fuſion; for the union it forms with the ſulphur renders it ſo fuſible, that it becomes itſelf a kind of flux.

This addition of iron in the eſſay of lead ores would be uſeleſs, if the ores were ſufficiently roaſted, ſo that no ſulphur ſhould remain.

Lead ores generally contain ſome ſilver, and ſometimes a conſiderable quantity of it; wherefore, after the ore has been eſſayed, and the regulus of lead collected and weighed, it ought to be teſted, to diſcover the quantity of ſilver it contains; and as ſometimes theſe lead ores contain alſo gold, the button of ſilver remaining upon the cupel ought to be eſſayed by parting, to aſcertain the quantity of gold, if there be any.

The details for the eſſays of all other ores and minerals are too numerous to be inſerted in this work. They are themſelves the ſubject of ſeveral books, which may be conſulted. The beſt of theſe books are Cramer's Art of Eſſaying *(Ars Docimaſtica)*, and Schlutter's Work tranſlated into French by Mr. Hellot. We ſhall find many things relating to this matter under the articles, ORES, SMELTING *of* ORES. *(o)*

(o) The eſſaying of ores is a matter of ſuch importance to chemiſtry, to arts, and to the wealth of nations, that we ſhall endeavour to ſupply what the author of the Dictionary has omitted on this ſubject, by adding to the ſeveral articles of the ores of metals the methods of eſſaying theſe ores. *See* ORES. We ſhall here only obſerve in general, that the methods generally practiſed for eſſaying ores of imperfect metals, and ſemi-metals eſpecially, are inſufficient to procure the whole quantity of metal contained in ores, or even ſo much as is obtained in the ſmelting of large quantities of ores; and that therefore the reſult of eſſays is not to be conſidered as the preciſe quantity contained in an ore, but generally only as an inaccurate approximation to that quantity. Mr. Gellert aſcribes one cauſe of the want of ſucceſs of theſe operations to the alkaline ſalts employed as fluxes to the ores, by which moſt metallic calxes are partially ſoluble, but more eſpecially ſo, when any of the ſulphur of the ore remains; which, by uniting with theſe ſalts, forms a hepar of ſulphur, which is the moſt powerful of all ſolvents. He propoſes therefore to omit the black flux, and other alkaline ſalts, and to add nothing to the ore but powder of charcoal, and ſome fuſible glaſs. This method, he ſays, he learned from Mr. Cramer, and has himſelf uſed with much ſucceſs in the eſſays of iron and copper: but finding that other imperfect metallic ſubſtances could not ſuſtain the heat neceſſary to effect the fuſion and vitrification of the unmetallic parts of the ore without being partly diſſipated, he found

ESSAY *of the* VALUE *of* SILVER, to examine its purity, or the quantity of alloy mixed with it. The common method of examining the purity of ſilver, is by mixing it with a quantity of lead proportionable to the quantity of imperfect metals with which it is ſuppoſed to be alloyed; by teſting this mixture; and afterwards by weighing the remaining button of ſilver. The loſs of weight which the ſilver ſuffers by cupellation ſhews the quantity of imperfect metals which it contained.

We may hence perceive, that the eſſay of ſilver is nothing elſe than the refining of it by cupellation. The only difference betwixt theſe two operations is, that when ſilver is teſted merely for the purpoſe of refining it, its value is generally known; and it is therefore mixed with the due proportion of lead, and teſted without any neceſſity of attending to the loſs of weight it ſuſtains during the operation; whereas in the eſſay all poſſible methods ought to be employed to aſcertain preciſely this loſs of weight. The firſt of theſe operations, or the mere refining of ſilver, is made in the great, in the ſmelting of ſilver ores, and in mints for making money. *See* REFINING. The ſecond operation is never made but in ſmall; becauſe the expences of ſmall operations are leſs than of great, and the requiſite accuracy is more eaſily attended to. The laſt operation is our preſent ſubject, and is to be performed in the following manner.

We ſuppoſe, firſt, that the maſs or ingot of ſilver, of which an eſſay is to be made, conſiſts of twelve parts perfectly equal, and theſe twelve parts are called penny-weights. Thus if the ingot of ſilver be an ounce weight, each of theſe twelve parts will be $\frac{1}{12}$ of an ounce; or if it be a mark, each of theſe will be $\frac{1}{12}$ of a mark, &c. Hence if the maſs of ſilver be free from all allay, it is called ſilver of twelve penny-weights; if it contains $\frac{1}{12}$ of its weight of allay, it is called ſilver of eleven penny-weights; if $\frac{2}{12}$ of its weight be allay, it is called ſilver of ten penny-

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found it neceſſary to add in the eſſays of theſe latter metallic matters ſome borax, by which the fuſion might be completed with leſs heat. As we conſider this as a conſiderable improvement in the art of eſſaying ores, we ſhall, to the articles of the ſeveral ores, add not only the proceſſes commonly preſcribed, but alſo theſe of Mr. Gellert, according to the method here mentioned. *See* ORES.

weights; and theſe ten penny-weights or parts of pure ſilver are called *fine penny-weights.*

We ought to obſerve here concerning theſe penny-weights, that eſſayers give alſo the name *penny-weight* to a weight equal to twenty-four real grains; which latter real penny-weight muſt not be confounded with the former, which is only ideal and proportional; and ſuch a confuſion is the more likely to take place, as this ideal penny-weight is alſo, like the former, divided into twenty-four ideal grains, which are called *fine grains.*

An ingot of fine ſilver, or ſilver of twelve penny-weights, contains then 288 fine grains; if this ingot contains $\frac{1}{288}$ of allay, it is ſaid to be ſilver of eleven penny-weight and twenty-three grains; if it contains $\frac{2}{288}$ of allay, it is called ſilver of eleven penny-weight and twenty-two grains; if it contains $\frac{14}{288}$, it is called ſilver of eleven penny-weight and ten grains; and ſo on. Laſtly, the fine grain has alſo its fractions, as $\frac{1}{2}$, $\frac{1}{4}$ of a grain, &c.

As eſſays to diſcover the value of ſilver are always made in ſmall, eſſayers only take a ſmall portion of an ingot for the trial, and the cuſtom in France is to take thirty-ſix real grains for this purpoſe, which is conſequently the largeſt weight they employ, and repreſents twelve fine penny-weights. This weight is ſubdivided into a ſufficient number of other ſmaller weights, which alſo repreſent fractions of fine penny-weights and grains. Thus eighteen real grains, which is half of the quantity employed, repreſent ſix fine penny-weights; three real grains repreſent one fine penny-weight, or twenty-four fine grains; a real grain and a half repreſent twelve fine grains; and $\frac{1}{32}$ part of a real grain repreſents $\frac{1}{4}$ part of a fine grain, which is only $\frac{1}{752}$ part of a maſs of twelve penny-weights.

We may eaſily perceive that weights ſo ſmall, and eſſay balances, ought to be exceedingly accurate. Theſe balances are very ſmall, ſuſpended and incloſed in a box the ſides of which are panes of glaſs, that they may be preſerved from duſt, and that their motion may not be affected by agitated air, ſo as to diſorder their action.

When an eſſay of a maſs or ingot of ſilver is to be made, the cuſtom is to make a double eſſay. For this purpoſe, two fictitious ſemi-marks, each of which may be equal to thirty-ſix real grains, are to be cut from the ingot. Theſe two portions of ſilver ought to be weighed very exactly; and they ought alſo to have been taken from oppoſite ſides of the ingot.

Perſons accuſtomed to theſe operations know pretty nearly the value of ſilver merely by the look of the ingot, and ſtill better by rubbing it on a touchſtone. By the judgment they form of the purity of the ingot, they regulate the quantity of lead which is to be added to it, as this quantity muſt be always proportionable to the quantity of imperfect metal mixed with the ſilver.

Nevertheleſs, this proportion of lead to the alloy has not been preciſely determined. Authors who treat of this ſubject differ much. They who direct the largeſt quantity of lead ſay, that thereby the alloy is more certainly deſtroyed; and others who direct a ſmall quantity of lead pretend, that no more of that metal ought to be uſed than is abſolutely neceſſary, becauſe it carries off with it always ſome portion of ſilver. Every eſſayer uſes his own particular method of proceeding, to which he is attached.

To aſcertain theſe doubtful points, three chemiſts of the Academy of Sciences at Paris, Meſſrs. Hellot, Tillet, and Macquer, were appointed by the French Government. They were directed to aſcertain every thing concerning the eſſay of gold and of ſilver by authenticated experiments, made under the inſpection of a miniſter whoſe ſuperior knowledge is equal to his deſire of public good, and in preſence of the officers of the mint.

The experiments made by theſe chemiſts, and the conſequent regulation, have determined that four parts of lead are requiſite for one part of ſilver of eleven penny-weight and twelve grains, that ſix parts of lead are requiſite for ſilver of eleven penny-weight, eight parts of lead for ſilver of ten penny-weight, ten parts of lead for ſilver of nine penny-weight, and ſo on in the ſame progreſſion.

Two cupels of equal ſize and weight are to be choſen. The cuſtom is to uſe cupels of ſuch a ſize, that their weight ſhall be equal to that of one half of the lead employed in the eſſay; becauſe ſuch cupels have been found capable of imbibing all the litharge formed during the operation. Theſe cupels are to be placed together under a muffle in an eſſay-furnace. The fire is to be kindled, and the cupels to be made red-hot, and to be kept ſo during half an hour at leaſt before any metal be put into them. This precaution is neceſſary to dry and calcine them perfectly; becauſe if they contained any moiſture or inflammable matter, an ebullition and efferveſcence would be occaſioned in the eſſay. When the cupels are heated ſo as to become almoſt white, the lead is to be put into them; the fire is to be encreaſed, which is done by opening the door of the aſh-hole ſo as to admit air, till the lead becomes red, ſmoking, and is agitated by a motion of its parts called its *circulation*, and till its ſurface becomes ſmooth and clear.

Then the ſilver, previouſly beat into ſmall plates for its eaſier fuſion, is to be put into the cupels; the fire is to be continued, and even encreaſed, by putting hot coals at the mouth of the muffle, till the ſilver ſhall have *entered the lead*, that is, till it have melted and mixed with the lead. When the melted matter circulates well, the heat is to be diminiſhed by taking away, partly or entirely, the coals put at the mouth of the muffle, and by cloſing more or leſs the doors of the furnace.

The heat ought to be regulated ſo, that the eſſays in the cupels ſhall have ſurfaces ſenſibly convex, and ſhall appear ardent, while the cupels are leſs red; that the ſmoke ſhall riſe almoſt to the roof of the muffle; that undulations ſhall be made in all directions upon the ſurfaces of the eſſays, which are called *circulations*; that their middles ſhall be ſmooth and ſurrounded with a ſmall circle of litharge, which is continually imbibed by the cupels.

The eſſays are to be kept in this ſtate till the operation is finiſhed, that is, till the lead and alloy have ſoaked into the cupel: and the ſurfaces of the buttons of ſilver being no longer covered with a pellicle of litharge, become ſuddenly bright and ſhining, and are then ſaid to *lighten*. If the operation has been well conducted, the two eſſays ought to become bright nearly at the ſame time. When the ſilver has been by this operation well refined, we may ſee, immediately after it has brightened, the ſurface of the ſilver covered with rainbow colors, which quickly undulate and croſs each other, and then the buttons become fixed or ſolid.

The management of the fire is an important article in eſſays. For if the heat be too great, the lead is ſcorified and imbibed by the cupel ſo quickly, that it has not ſufficient time to ſcorify and carry along with it all the alloy; and if the heat be too little, the litharge is gathered upon the ſurface, and does not penetrate the cupel. The eſſayers ſay then that the eſſay is *choaked* or *drowned*. In this caſe the eſſay does not advance, becauſe the litharge covering the ſurface of the metal defends it from the contact of air, which is abſolutely neceſſary for the calcination of metals. *See* CALCINATION *and* COMBUSTION.

We have above related the marks of a ſucceſsful eſſay. The heat may be known to be too great, from the convexity of the ſurface of the melted metal; from a too ſtrong circulation; from the too vivid appearance of the cupel, ſo that the colors given to it by the litharge cannot be diſtinguiſhed; and laſtly, by the ſmoke riſing up to the roof of the muffle, or not being at all viſible, from its being ſo ardent and red-hot as not to be diſtinguiſhable. In this caſe the heat muſt be diminiſhed by ſhutting the door of the aſh-hole: Some eſſayers, for this purpoſe, put round the cupels ſmall, oblong, cold pieces of baked clay, which they call *inſtruments.*

If, on the contrary, the melted metal have a ſurface not very ſpherical, relatively to its extent; if the cupel appear dark colored, and the ſmoke of the eſſay do only creep upon the ſurface; if the circulation be too weak, and the ſcoria which appears like bright drops have but a dull motion, and are not ſoaked into the cupel; we may be aſſured that the heat is too weak; much more may we be aſſured of it when the metal *fixes*, as the eſſayers call it. In this caſe, the fire ought to be encreaſed by opening the door of the aſh-hole, and by placing large burning coals at the mouth of the muffle, or even by laying them acroſs upon the cupels.

As ſoon as the lead is put into the cupels, the fire is to be encreaſed, becauſe they are then cooled by the cold metal, and the lead ought to be quickly melted, to prevent its calx from collecting upon its ſurface in too great quantity before it be formed into litharge; which it would do, and be difficultly fuſed, if the heat were too weak.

When the ſilver is added to the lead, the heat muſt be ſtill encreaſed, not only becauſe the ſilver cools the maſs, but becauſe it is leſs fuſible than lead. And as all theſe effects ought to be produced as quickly as poſſible, more heat is at length given than ought to be continued; and therefore, when the ſilver has entered the lead, the heat is to be diminiſhed till it becomes of a due intenſity for the operation.

During the operation the heat ought gradually to be augmented to the end of it, both becauſe the metallic mixture becomes leſs fuſible as the quantity of lead diminiſhes, and alſo becauſe the lead is more difficultly ſcorifiable, as it is united with a larger proportion of ſilver. Hence the eſſays muſt be rendered very hot before they brighten.

When

When the operation is finiſhed, the cupels are left in the ſame heat during ſome ſeconds, to give time to the laſt portions of litharge to be entirely abſorbed; becauſe if any of it remained under the buttons of ſilver, it would ſtick to them. The fire is then allowed to extinguiſh, and the cupels to cool gradually, till the buttons have entirely fixed, particularly if they be pretty large; becauſe if they cool too quickly, their ſurfaces fix and contract before the internal maſs, which is thereby ſo ſtrongly compreſſed as to burſt through the external ſolid coat and form vegetations, or even to be entirely detached from the reſt of the maſs and diſſipated. This is called *the vegetation of the button.* It ought to be carefully prevented, becauſe ſmall bits of ſilver are ſometimes thrown out of the cupel.

Laſtly, when the buttons are thoroughly fixed, they are to be diſengaged from the cupels by a ſmall iron utenſil while they are yet hot, otherwiſe they could not be diſengaged clean and free from part of the cupels which ſtrongly adhere to them when the heat is much diminiſhed.

Nothing then remains to compleat the eſſay but to weigh the buttons. The diminution of weight which they have ſuſtained by cupellation will ſhow the purity or value of the ingot of ſilver.

We ought to obſerve, that as almoſt all lead naturally contains ſilver, and that after cupellation this ſilver is mixed with the ſilver of the ingot in the button of the eſſay; before we employ any lead in this operation, we ought to know how much ſilver it contains, that we may ſubtract this quantity from the weight of the button, when we compute the fineneſs of the ſilver of the ingot eſſayed. For this purpoſe eſſayers generally cupel a certain quantity of their lead ſeparately, and weigh accurately the button of ſilver it yields: or, at the ſame time when they eſſay ſilver, they put into a third cupel, in the muffle, a quantity of lead equal to that employed in both their eſſays; and when the operation is finiſhed, and the buttons are to be weighed, they throw the ſmall button produced from the lead alone into the ſcale which contains the weights; and as this exactly counterpoiſes the ſmall portion of ſilver which the eſſay buttons have received from the lead employed in the cupellation, the weights will ſhew preciſely the quantity of ſilver contained in the ingot, and thus the trouble of calculating is prevented. The ſmall button of ſilver procured from the cupellation of lead alone is called the *witneſs*. But to prevent this trouble, eſſayers generally employ lead which contains no ſilver, ſuch as that from Willach in Carinthia, which is therefore procured by eſſayers.

In the ſecond place we ſhall obſerve, that a certain quantity of ſilver always paſſes into the cupel, as refiners in the great have long obſerved, and which happens alſo in eſſaying ſmall quantities. The quantity of ſilver thus abſorbed, varies according to the quantity of the lead employed, and the matter and form of the cupels; all which objects will undoubtedly be determined by the above mentioned chemiſts.

The cupellation which we have now deſcribed is exactly the ſame for eſſays, by which the produce of a ſilver ore, or of an ore of another metal containing ſilver, is determined. But as theſe ores contain frequently gold, and ſometimes in conſiderable quantity, when theſe eſſays are made, the buttons of ſilver obtained by the eſſays ought to be ſubjected to the operation called *parting*. *See* SILVER, REFINING, FURNACE (ESSAY), MUFFLE, *and* CUPEL. *(p)*

(p) M. Tillet has publiſhed a memoir, ſhewing that eſſays of ſilver made in the common method are uncertain and not to be depended upon, and that this uncertainty proceeds from the different quantities of ſilver abſorbed by the cupel in different eſſays, according as the heat, and other circumſtances happened to vary. He therefore propoſes, in order to render eſſays accurate, to extract from the cupel the quantity of ſilver it has abſorbed during the operation, and to add this particle of ſilver to the button, as theſe two contain the whole quantity of ſilver in the matter eſſayed.

The variations in the different reſults of different eſſayers, or of the ſame eſſayer at different times, upon the ſame maſs of ſilver, are ſufficient proofs of the uncertainty mentioned by M. Tillet. Theſe variations are occaſioned, according to that author, principally from the following cauſes: 1. From the inaccuracy of the balances and weights employed. 2. From the faulty fuſion of the maſs to be eſſayed; by which means, the contained alloy may be unequally diffuſed. 3. From the impurity of the lead, eſpecially from its containing ſilver, which is not always equally diffuſed through its maſs. 4. From the different proportions of lead uſed by different eſſayers. 5. From the difference of the intenſity of heat; for, if the heat be not ſufficiently intenſe, the ſilver will ſtill contain a portion of alloy; and if the heat be too intenſe, too much of the ſilver will be imbibed by the cupel. 6. From the want of care in picking the ſmall particles of ſilver which frequently adhere to the ſides of the

ESSAY *of the* VALUE *of* GOLD. The fictitious weights uſed to determine the purity of gold, and to eſſay this metal, are different from thoſe of ſilver. *See the preceding article.* A maſs of gold perfectly pure, or which contains no alloy, is ideally divided into 24 parts, called *carats*; this pure gold is therefore called gold of 24 carats,

the cupel ſeparately from the principal button. 7. From the ſpurting which ſometimes happens unobſerved by the eſſayer, and which may further falſify the eſſays of other pieces included under the ſame muffle, by the falling of the particles thrown out of one cupel into others adjacent. But with all the attentions to avoid theſe cauſes of error, the author obtained different reſults from different eſſays of the ſame maſs of ſilver. Nor could he, by any method, make his different eſſays conſiſtent with each other, but by adding to each button the particle extracted from the cupel; and this method he found by accurate experiments to be perfectly exact.

M. Tillet obſerved, that the quantity of lead directed in the regulations eſtabliſhed in conſequence of the report made by Meſſrs. Macquer, Hellot and Tillet, is not ſufficient to purify the ſilver perfectly from its alloy. He nevertheleſs approves of the ſaid regulation, and conſiders the weight of the alloy retained by the button, as ſome compenſation for the weight of the ſilver abſorbed by the cupel. And as it is a conſtant fact, that the more lead is uſed, the greater is the loſs by the abſorption of the cupel, he remarks that a regulation directing a larger proportion of lead for France, than is uſed in other countries, would be diſadvantageous to that kingdom, as thereby the ſilver of the ſame denomination would be required to be finer in that than in other countries where a leſs proportion of lead was employed. He obſerves that the above-mentioned rule, "that the more lead is uſed, the greater is the loſs by the abſorption of the cupel," does not extend to quantities of lead much above double the uſual quantities. Thus thirty-two parts of lead to one of ſilver will not occaſion more abſorption than ſixteen parts of lead. For the refining ſcarcely takes place till the extraordinary quantity of lead be gone, and the ſilver is only or chiefly carried into the cupel along with the copper. Accordingly, he found that he could render the ſilver finer by uſing four parts of lead at firſt, and afterwards adding two more parts when the iriſes began to appear, than by employing all the ſix parts of the lead at once. By this method of dividing the quantity of lead, the loſs of ſilver by abſorption was greater. M. Tillet did not find, that by employing biſmuth alone or mixed with lead, his eſſays were more certain than when lead alone was uſed. He obſerved, however, that the addition of biſmuth made the ſilver purer, but occaſioned a greater abſorption by the cupel.

If the maſs or ingot contain $\frac{1}{24}$ part of its weight of alloy, the gold is then of 23 carats; and if it contains $\frac{2}{24}$ or $\frac{1}{12}$ of alloy, it is gold of 22 carats, &c. Hence we ſee that the carat of gold is only a relative and proportional weight, ſo that the real weight of the carat varies according to the total weight of the maſs of gold to be examined. If this maſs of gold weighs a mark, the real weight of the carat will be $\frac{1}{24}$ of eight ounces, which is equal to a mark. If the maſs weigh an ounce, the carat will be $\frac{1}{24}$ part of an ounce, or 24 grains. If it is only a penny-weight or 24 grains, the real weight of a carat will be one grain; and ſo on.

For greater accuracy, the carat of gold is divided into 32 parts, which are relative and proportional weights, as the carat itſelf is. Thus $\frac{1}{32}$ of a carat of gold is $\frac{1}{32}$ of $\frac{1}{24}$, or the $\frac{1}{768}$ of any maſs of gold; and the gold which contains an alloy equal to the $\frac{1}{768}$ part of the whole maſs is called gold of 23 carats and $\frac{31}{32}$; gold which contains $\frac{2}{768}$ of alloy is gold of 23 carats and $\frac{30}{32}$; and ſo on.

The real weight now generally uſed in the operation for determining the purity of gold, is ſix grains. This weight then repreſents 24 carats. The half of this weight, or three real grains, repreſents 12 carats. According to this progreſſion, we ſhall find that $\frac{1}{4}$ of a real grain repreſents one carat, and the $\frac{1}{128}$ parts of a grain repreſents the $\frac{1}{32}$ of a carat, or the $\frac{1}{768}$ part of a maſs of gold to be eſſayed.

As theſe weights are exceedingly ſmall, ſome eſſayers employ a weight of 12 grains, which muſt be very convenient.

When a maſs or ingot of gold is to be eſſayed, ſix grains are to be cut off, and exactly weighed: alſo 18 grains of fine ſilver are to be weighed. Theſe two metals are to be cupelled together with about ten times as much lead as the weight of the gold. This cupellation is conducted preciſely like that of the eſſay to determine the purity of ſilver, excepting that the heat muſt be raiſed a little more towards the end of the operation when the eſſay is going to brighten. Then the gold is freed from all alloy but ſilver. If the quantity of copper or other alloy deſtructible by cupellation be required to be known, the remaining button is accurately weighed. The diminution of weight from the ſum of the weights of the gold and of the ſilver determines the quantity of this alloy.

The button containing gold and ſilver is then to be flattened upon a poliſhed piece of ſteel, and care muſt be taken to anneal it from time to time, to prevent its ſplitting and cracking. By this method it is reduced to a thin plate, which is to be rolled up, in order to be parted by aqua-fortis. *See the word* PARTING. The diminution ſound after the parting from the original weight of the gold eſſayed, ſhews the whole quantity of alloy contained in that gold.

The eſſay for determining the purity of gold is then made by two operations: the firſt, which is cupellation, deprives it of all its imperfect metals; and the ſecond, which is parting, ſeparates all the ſilver from it. By antimony alſo gold may be purified, which is a kind of dry parting. By this ſingle operation, all the imperfect metals, and ſilver with which gold is allayed, are ſeparated. *See* PURIFICATION *of* GOLD *by* ANTIMONY. *See alſo* GOLD, SILVER, REFINING, ESSAY *of the* VALUE *of* SILVER.

ESSENCES. Eſſential oils are ſometimes called *eſſences*. Thus we ſay, eſſence of cinnamon, of turpentine, &c. to denote the eſſential oils of theſe ſubſtances. *See* OILS (ESSENTIAL).

ETHER. Ether is a white, tranſparent liquor, of a peculiar and penetrating ſmell. Ether is very volatile; it may be entirely diſtilled without leaving any reſiduum, or ſuffering any decompoſition or alteration. It is more volatile and inflammable than rectified ſpirit of wine. Its flame reſembles the flame of ſpirit of wine; but it is ſenſibly much greater, whiter, and more luminous. It is alſo accompanied with a ſlight ſmoke or ſoot, which ſpirit of wine is not.

Ether does not mix with water, as ſpirit of wine does, in all proportions; but ten parts of water are required to diſſolve one part of ether. This liquor has alſo a power of acting upon all oily and fat ſubſtances.

From theſe eſſential properties ether appears to be a ſubſtance exactly intermediate betwixt ardent ſpirits and oils, as has been proved in the elements of chemiſtry. *See* SPIRIT (ARDENT), *and* OIL.

Ether has been but lately known by chemiſts. From certain paſſages indeed of ſome old chemical books, we may infer that ether was not entirely unknown to their authors; but they have not mentioned it diſtinctly, nor have they ſufficiently deſcribed its properties, or the manner of making it: wherefore no attention was given to it, till the curioſity of chemiſts was excited by a publication in the Philoſophical Tranſactions for the year 1730, by a German who calls himſelf Frobenius, (which however is ſuppoſed to be a feigned name) in which he relates the experiments he had made on that liquor, to which he firſt gave the name *ether*. Since that time, many chemiſts have made experiments on this matter. At firſt they made ether difficultly and in ſmall quantities, and at length abundantly and eaſily; particularly ſince Mr. Hellot communicated to ſeveral artiſts a proceſs which he received from a foreign chemiſt. This proceſs has been printed in the Encyclopedia with conſent of Mr. Hellot.

Since that time, Mr. Beaumé has operated more than any other chemiſt on ether. He has publiſhed the details of his experiments and reſearches, not only upon ether, but upon all the other ſubſtances produced from a combination of ſpirit of wine with vitriolic acid. This forms the completeſt treatiſe on this ſubject which has hitherto been publiſhed.

Vitriolic acid is not the only acid from the mixture of which with ſpirit of wine ether may be produced. The nitrous, marine, and acetous acids have alſo been found capable of forming, with ſpirit of wine, liquors poſſeſſed of all the eſſential properties of ether; but differing from ether, properly ſo called, or vitriolic ether, by properties peculiar to each. We ſhall ſpeak ſucceſſively of theſe different ethers, beginning with the vitriolic, called ſimply *ether*, becauſe it is the chief one and the firſt diſcovered. The following proceſs for making this ether, which is the beſt hitherto publiſhed, is extracted from Mr. Beaumé's diſſertation.

Put two pounds of perfectly rectified ſpirit of wine into a glaſs retort, and pour upon it at once two pounds of well concentrated vitriolic acid.

This acid being much heavier than the ſpirit of wine, ſinks directly to the bottom, and does not mix with the ſpirit of wine. Shake the retort gently, and repeatedly, that the two liquors may mix. The mixture will boil, and become very hot. Vapors will iſſue from it with a loud hiſſing noiſe, and a ſweet penetrating ſmell. The mixture will then aſſume a yellow-reddiſh color. Place the retort in a ſand-bath, warmed by degrees to the ſame heat with itſelf. Lute to it a receiver, in the ſide of which is a ſmall hole, and diſtill the mixture by a heat ſufficiently intenſe to make it quickly boil and to keep it boiling. At firſt a very ſweet ſpirit of wine will paſs into the receiver, after which the ether will come, which may be diſtinguiſhed by ſtriæ formed on the upper part and neck of the retort. Continue the diſtillation with the ſame degree of fire, and from time to time unſtop the ſmall hole of the receiver, till you perceive, upon applying your noſe near this ſmall hole, a ſuffocating ſmell of volatile ſulphureous acid. Then the receiver ought to be unluted; and the contained liquor, which will be nearly eighteen ounces, muſt be quickly poured into a glaſs bottle, which ought to be well ſtopped. This liquor is a mixture of a very dephlegmated part of the ſpirit of wine, of a ſweet penetrating ſmell, which paſſes at firſt; of ether, which was formed during the diſtillation; of a little oil; and ſometimes alſo of a ſmall quantity of ſulphureous acid; both which ſubſtances paſs frequently with the laſt portions of the ether, particularly if the diſtillation has been too long continued. To ſeparate the ether from theſe other ſubſtances, put the whole mixture into a glaſs retort, with a little deliquiated fixed alkali, to abſorb and retain the ſulphureous acid, and diſtill very ſlowly in a ſand-bath, with a very gentle lamp heat, till you have made one half of the liquor paſs over. The liquor that riſes in this diſtillation, called alſo *rectification*, is ether.

Before the Count de Lauraguais had diſcovered that ether was miſcible with water in a certain proportion, the cuſtom was to put the ether after this diſtillation into a phial with diſtilled water, and to ſhake together theſe two liquors. The ether roſe quickly to the ſurface, and floated on the water; from which it might be ſeparated by a funnel, as oil may from water, and obtained unmixed. But this is evidently bad management: for in the firſt place, the water thus mixed diſſolves about one tenth part of its weight of ether before it is ſaturated, all which is loſt; and in the ſecond place, for the ſame reaſon that water diſſolves ſome ether, the ether alſo diſſolves a certain quantity of water, by which it is weakened, and its properties altered, as Mr. Beaume has obſerved.

The production of ether is one of the moſt beautiful and inſtructive phenomena of chemiſtry. Spirit of wine, which is at once inflammable, and miſcible with water in all proportions, differs from any oil by containing a more conſiderable quantity of water, which enters its compoſition as a principal or conſtituent part. This being eſtabliſhed, if we deprive ſpirit of wine of part of that aqueous principle by which it differs from oils, it ought to aſſume the character of oil, and to approach ſo much more to an oily nature, as it has been deprived of a greater quantity of the watery principle which conſtitutes it ſpirit of wine, and by which it differs from oil. But this is preciſely what happens to it in the production of ether, and in the analyſis of the remaining mixture after the formation of ether.

Concentrated vitriolic acid having a power of attracting water ſtrongly, does, when mixed with ſpirit of wine, accordingly at firſt unite with the water which the ſpirit of wine may contain ſuperabundantly: and its action would not extend farther, and it would not ſeparate the watery principle from the ſpirit of wine, if a heat were not applied ſufficient for diſtillation; for ether cannot be obtained from this mixture but by diſtillation. But when by the diſtilling heat the power of the vitriolic acid to attract water is encreaſed, that acid then becomes capable of ſeparating the watery principle of the ſpirit of wine and of uniting with it.

As this is done gradually, ſo the ſpirit of wine which riſes in diſtillation ought to be more and more changed by the action of the vitriolic acid.

This accordingly happens; and very diſtinctly. The firſt liquor which riſes in this diſtillation is a portion of ſpirit of wine, very volatile, penetrating, and dephlegmated; but which has not been deprived of its watery principle, and therefore retains the eſſential properties of ſpirit of wine.

The liquor which riſes next is ſpirit of wine, deprived of part of its watery principle by vitriolic acid. It conſequently is ſpirit of wine eſſentially altered, and approximated to the nature of oil, in proportion to the quantity of watery principle which it has loſt. This is ether, which differs from ſpirit of wine in being no longer miſcible with water in all proportions, and in emitting a whiter and more brilliant flame, accompanied with ſome fuliginous ſmoke.

Theſe properties by which ether differs from ſpirit of wine characterize ſo well its oily nature, that moſt chemiſts conſider this liquor as a very volatile oil. It ſeems, however, to be rather an intermediate ſubſtance betwixt oil and ſpirit of wine. The ſolubility of ether by water makes us chiefly conſider it in this light; for what oil, properly ſo called, can be diſſolved by water as ether can?

If the diſtillation of the mixture be continued after the ether has riſen, the vitriolic acid, ſtill continuing its action upon the ſpirit of wine already altered, takes at length from it all the watery principle by which it differs from a true oil, and hence ought to leave it in the ſtate of oil. Accordingly, after the ether has paſſed over in diſtillation, an oil riſes which wants none of the eſſential properties of true oil, as it is not miſcible with water, burns with a fuliginous ſmoke, leaves a reſinous coal, &c. This oil, thus created in ſome meaſure during the operation, is known by the name improperly given to it, of *Sweet Oil of Vitriol.*

From all this we might infer, that if ether ready prepared were mixed and diſtilled with concentrated vitriolic acid, it ought to be changed and transformed into ſweet oil of vitriol. Accordingly Mr. Beaumé obſerved, that this did happen in an experiment he made, an account of which is given in his Diſſertation on Ether.

When the ſweet oil of vitriol is diſtilling, the vitriolic acid acts alſo upon the phlogiſton of the remaining part of the ſpirit of wine, and unites with one part of the inflammable principle. Hence we may ſee at the ſame time much ſulphureous, volatile, ſuffocating acid paſs in diſtillation. But as the vitriolic acid which forms it then becomes charged with all the water which it has taken from the ſpirit of wine, this firſt ſulphureous acid, although very quick and penetrating, is very aqueous, and has not much acidity.

By continuing this diſtillation, with a graduated fire, to perfect dryneſs, more of this ſulphureous acid is raiſed, which becomes more and more acid; ſometimes alſo a little concrete ſulphur is ſublimed to the neck of the retort towards the end of the diſtillation, and a fixed coal remains, as we ought to ſuppoſe; for the ſame ſubſtances are obtained by diſtilling to dryneſs a mixture of any oil with concentrated vitriolic acid. *See* OIL.

From all that has been ſaid concerning the nature and properties of ether we may conclude, that this ſubſtance is nothing elſe than ſpirit of wine deprived by vitriolic acid of a part of its aqueous principle, and thereby approximated to the nature of oil. Some chemiſts believe that vitriolic acid is a conſtituent part of ether. This opinion, although it is not demonſtrated, is not however deſtitute of probability, and deſerves to be examined by experiments. For, on one ſide, a more copious and diſtinct acid is contained in all oils than in ſpirit of wine; and on the other ſide, the particular properties by which ethers formed by the nitrous, marine, and acetous acids differ from vitriolic ether, ſeem to be owing to adhering portions of the acids with which theſe ethers are prepared. This queſtion requires a particular examination.

Ether is not employed in the arts, although it appears capable of being uſefully employed in many caſes, and particularly in the ſolution of certain concrete oily matters for the preparation of varniſhes; but its high price prevents its introduction into the arts.

As ether is the moſt volatile and evaporable of all known liquors, and as in general liquors produce a degree of cold proportionable to the quickneſs of their evaporation, as Mr. Beaumé diſcovered, and ſeveral others have obſerved; therefore a very great degree of artificial cold may be produced by means of ether. Mr. Beaumé has ſunk the mercury of Reaumur's thermometer to 40 degrees below the freezing point, by applying linens ſoaked in ether to the ball containing the mercury; and he makes this fine experiment every year in his courſe of chemiſtry conjointly with Mr. Macquer. *(q)*

Ether, like all thin and volatile oily matters, has the property of taking gold from aqua regia; but as it is more ſubtle than any other of theſe matters, it produces this effect better. For this purpoſe, ether ought to be poured upon a ſolution of gold in aqua regia, and the two liquors mixed together by ſhaking the containing phial. When this mixture is left to reſt, the ether ſoon diſengages itſelf from the aqua regia, and floats on the ſurface of the acid liquor, which being deprived of its gold is rendered white, while the ether has now acquired a yellow color from the gold it contains. This is an expeditious method of making a tincture of gold, or portable gold. We ought to obſerve that the gold which thus paſſes into the ether ſtill retains a certain quantity of aqua regia.

Ether is employed in medicine. As a very thin and volatile inflammable matter, it acts powerfully on the nervous ſyſtem, like all the matters of this kind. Frederic Hoffman was one of the firſt who employed it as a ſedative and antiſpaſmodic. The famous mineral anodyne liquor of this phyſician is nothing elſe than ſpirit of wine, in which are

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(q) Mr. Amonſtons, in a Memoir of the Academy of Paris, (1699) and more particularly, M. Richman, in a Memoir of the Academy of Peterſburg, (1747) have obſerved that cold was produced by evaporating fluids. Dr. Cullen diſcovered, that the cold thus produced by evaporating fluids was conſiderably greater in vacuo than in air. *See Eſſays Phyſ. & Liter.* Edinburgh, vol. 2, 1756.

diſſolved ſome ether and ſweet oil of vitriol. It owes all its medicinal virtues to the ether.

Since ether has become more common and better known, many phyſicians preſcribe it ſingly, in the doſe of ſeven or eight drops upon a bit of ſugar, which is to be eat, or to be diſſolved in ſome proper liquor and drank. It is given in flatulent colics, obſtinate hiccups, convulſive, hyſterical affections, and other diſorders of this kind. It certainly produces frequently excellent effects; but, like all other antiſpaſmodic remedies, it ſometimes produces none.

Several perſons have affirmed, that ether applied externally to the back of the neck, or to the temples, diſſipated inſtantaneouſly, and as it were by enchantment, head-achs and meagrims. I have tried it in all doſes upon myſelf for theſe diſorders, but without ſucceſs; but we cannot from thence infer that it may not have better effects upon other perſons. *(r)*

ETHER (ACETOUS). Since the diſcovery of the ether deſcribed in the preceding article, chemiſts have endeavoured to obtain ſuch a liquor from ſpirit of wine by means of other acids; and accordingly they produced it firſt by means of the nitrous acid, then by the acetous, and laſtly, by the marine. We ſhall ſpeak ſucceſſively of theſe ſeveral ethers.

The diſcovery of the production of ether by the acetous acid was made by the Count de Lauraguais. This ether is made by mixing together equal parts of rectified ſpirit of wine, and concentrated acid of vinegar obtained by diſtilling cryſtals of copper, called the Spirit of Venus, or radical vinegar. This mixture is to be diſtilled in the manner directed for vitriolic ether, and a conſiderable quantity of a liquor is obtained, which is poſſeſſed of the eſſential qualities of ether, as deſcribed in the former article, but which has alſo ſome of the acidity and peculiar ſmell of radical vinegar.

When this ether is mixed with liquid fixed alkali, and again diſtilled, or rectified by a lamp heat, an acetous ether is obtained, free from ſuperabundant acid, and much

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(r) Ether diſſolves all eſſential and expreſſed oils, animal empyreumatic oil, reſins, and almoſt entirely ambergriſe. It diſſolves difficultly petroleum and oil of amber. It precipitates regulus of antimony from aqua regia, and ſilver from nitrous acid. It takes ſpots of greaſe from ſilks without affecting their colors.

liker to true ether. It retains, however, the ſmell, not of the acid, but of the inflammable part of vinegar.

We obſerve, that by this proceſs a greater quantity of ether is obtained than by diſtillation with vitriolic acid, which ſhews that the acid of vinegar is eſſentially fitter to produce ether than the vitriolic acid. This difference muſt undoubtedly be attributed to the great quantity of ardent ſpirit, which is one of the principles of the acid of vinegar, and which perhaps already approaches the ſtate of ether. *See* VINEGAR (RADICAL).

As this diſcovery has been but lately made, the properties of the acetous ether, and the phenomena which its reſiduum may afford, have not yet been ſufficiently examined.

ETHER (MARINE). The diſcovery of the true proceſs for making ether by means of the marine acid, is the lateſt which has been made on this ſubject. The Marquis de Courtanvaux has communicated his proceſs to the Academy of Sciences.

The difficulty with which marine acid unites in general with inflammable ſubſtances has retarded the diſcovery of marine ether; for no ether can be obtained by treating the moſt concentrated marine acid with ſpirit of wine in the ordinary method, by which the other ethers are procured. Able artiſts, and particularly Mr. Rouelle and Mr. Beaumé, had attempted unſucceſsfully to procure ether by diſtilling ſmoking marine acid with ſpirit of wine. Mr. Beaumé, indeed, in his Diſſertation concerning Ether, has given a proceſs, by which he affirms, that he had obtained a ſmall quantity of marine ether. This proceſs conſiſts in making the fumes of the marine acid and of the ſpirit of wine meet together in the ſame receiver. But the quantity of ether obtained by this method was very ſmall. The proceſs alſo is troubleſome, and even imperfect, as Mr. Beaumé himſelf declares he would not have publiſhed it in that imperfect ſtate, but becauſe the poſſibility of the fact had been denied. What he ſays may be ſeen in his Diſſertation on Ether. (*s*)

Others

(*s*) The method employed by Mr. Beaumé for obtaining a marine ether, namely, by making the vapors of ſpirit of wine and thoſe of the marine acid meet and unite together in the ſame receiver, although it did not ſucceed well with him, has been ſucceſsfully attempted by Mr. Woulfe. This ingenious Chemiſt condenſed the

Others, and particularly German chemiſts, had attempted to employ for this purpoſe a marine acid which was united with a metallic ſubſtance, ſuch as the butter of antimony, and had obſerved the ſingular phenomena which happened in theſe mixtures. The Marquis de Courtanvaux has perfectly ſucceeded by employing the ſmoking ſpirit of Libavius, which is a highly concentrated marine acid, obtained from corroſive ſublimate by tin, and impregnated with a conſiderable quantity of this metal.

This

the united vapors of the ſpirit of wine and of the marine acid, by making them paſs from the receiver, through a tube, into ſpirit of wine contained in a bottle, and thoſe which were not thus condenſed through another tube into more ſpirit of wine contained in another bottle. By diſtilling and cohobating with ſlaked lime the liquors in the receiver and in the two above-mentioned bottles, he obtained a very ſubtle and penetrating ether, which upon being mixed with water cauſed a violent ebullition, although it was perfectly free from any acid. *See* a deſcription of the apparatus employed by Mr. Woulfe, and many curious particulars concerning diſtillation, in the *Phil. Tranſ.* Vol. 57.

Mr. le Baron de Bormes has publiſhed in the *Memoires des Sçavans Etrangeres, Tom.* 6. the following proceſs for making a marine ether by means of zinc; by which method a greater produce of ether may be obtained, and with leſs trouble, than in any other manner before diſcovered.

PROCESS OF MARINE ETHER.

" Take twelve pounds of ordinary ſpirit of ſalt, diſtilled a ſecond time over more ſalt, in order to render it more pure and free from all vitriolic parts. Saturate this acid with flowers of zinc, and digeſt it during 24 hours, taking care not to add any more flowers of zinc till the former be diſſolved, and the effervescence finiſhed. Filtrate this ſolution, and fill $\frac{1}{3}$ of a glaſs retort with it. Set the retort in a ſand-bath, and diſtil by a very gentle heat, and draw over all the phlegm that will come. It is not neceſſary to lute the veſſels, for all that paſſes is only phlegm, the acid being obſtinately retained by the flowers of zinc. This firſt operation is only intended to concentrate the marine acid.

" When your ſolution becomes thick, tranſparent, and of a deep golden color, let the fire ceaſe, and the veſſels cool. The ſolution will be then reduced to a quarter of its former bulk. When it cools, your liquor will fix and have the appearance of greaſe. Add to it, when cold, ſix pounds of very pure and well dephlegmated ſpirit of wine, by degrees, and at the ſame time, keep

This ſmoking liquor, mixed with an equal part of ſpirit of wine, and diſtilled together, eaſily produces a conſiderable quantity of a liquor poſſeſſed of all the eſſential properties of ether, and which may be conſidered as a true marine ether. The tin contained in the ſpirit of Libavius is ſeparated and precipitated in form of a white powder. This ether, like the others, muſt be rectified to be obtained in its greateſt purity. Some reflections concerning its nature will be found at the end of the following article.

ſhaking the retort. The matters during their ſolution, will become very hot. When the retort is become ſo hot that there remains no danger of its breaking, add the reſt of your ſpirit of wine. Replace your retort in the ſand-bath, previouſly heated nearly to the temperature of the retort, and leave it to digeſt during eight days, or till all the matter be diſſolved, excepting a powder which depoſits, and is of no uſe in the operation. Then filtrate all the liquor, and put it again into a dry clean retort. Set the retort in a ſand-bath, and fit to it a receiver ſufficiently large for the circulation of the ſpirits, but do not lute the joinings of the veſſels, for however well your ſpirit of wine has been rectified, you will draw over half the quantity of phlegm.

" Begin your diſtillation by a very gentle heat, which you may gradually augment till the liquor boils a little. The phlegm, I ſay, will paſs firſt.

" When you begin to ſee ſtriæ in the neck of the retort, and to perceive an agreeable ſmell ſpread over the laboratory, throw away the phlegm; and replace the receiver. Lute carefully the joints, and continue the ſame heat till all the aromatic ſpirit of wine has paſſed. At this time the matter in the retort will have become thick and like melted wax. Now the ether will be formed and begin to paſs. The ſame heat is to be continued till the matter in the retort be dry, when the heat ought to be encreaſed, that the *ſweet oil*, which is like a fine eſſence of citron, may paſs. This oil will ſwim upon the Ether, and the diſtillation is to be continued till no more of it paſſes.

" We may obſerve, that if the fire be raiſed too much before the matter is reduced to a dry maſs, it will ſwell, and fall back again into the receiver, which would make the operation fail.

" When no more can be diſtilled, let all cool ; and when the retort is but juſt warm, unlute the receiver, ſeparate the liquor from the ſweet oil by means of a funnel or ſeparating glaſs, and ſet them apart in bottles well ſtoppered.

" When you would have the ether pure, take the clear liquor, and diſtil it with the moſt gentle heat of a lamp. Take the aromatic ſpirit of wine that remains after drawing off the ether,

ETHER (NITROUS). This ether is obtained by mixing nitrous acid with ſpirit of wine, but with peculiar circumſtances.

In the writings of ancient chemiſts traces of the nitrous as well as of the other ethers may be found; but theſe traces are neither clear nor preciſe. The firſt perſon who publiſhed a ſatisfactory account of this liquor, and who ſhewed the true method of obtaining it, was Mr. Navier, a Phyſician, at Chalons-ſur-Marne, and Correſpondent of the Academy of Sciences. His proceſs, which he com-

and pour it back on the reſiduum in the retort, which ought to have been carefully ſtopped to prevent its attracting the moiſture of the air, which it does moſt powerfully. Proceed as you did before, and you will obtain more ſweet oil, ether, and aromatic ſpirit of wine. This may be repeated till almoſt the whole of your aromatic ſpirit be converted into ſweet oil and into ether. The number of theſe repetitions cannot be determined in order to obtain the whole of the ſweet oil and ether, as it depends much on the preparation of the flowers of zinc, on the quality of the ſpirit of ſalt and of the ſpirit of wine, and on the manner of conducting the operation. However, we may ſay, that if theſe circumſtances be proper, a good operator will obtain at leaſt two pounds of ether and four ounces of ſweet oil.

" This marine ether appears to me to be more penetrating and fragrant than the vitriolic; and the ſweet oil is equal if not ſuperior to all aromatic eſſences either in ſmell or ſubtlety. I believe that this is the true eſſential oil of wine, as much purified as it can be.

" In this operation no ſulphureous ſpirit is obtained, as when the vitriolic acid is employed. This circumſtance is very advantageous, and contributes to the obtaining a larger quantity of ether and ſweet oil.

" Our ether does not, I believe, require to be rectified over fixed alkali, as is commonly done with vitriolic ether, in order to cleanſe it from any ſuperabundant acid.

" This ether may be waſhed in water, on the ſurface of which it ſwims, while a white matter is precipitated. It precipitates a ſolution of ſilver into luna cornea; which ſhews its origin.

" Laſtly, it is a very ſingular and ſurpriſing fact, that the ſame maſs which remains dry at the bottom of the retort, and which ſerved to make the ether, may be employed, again and again, without end, for the ſame purpoſe, and without addition of more flowers of zinc. For, by re-diſſolving this maſs in ſpirit of ſalt, and by filtrating, and re-diſtilling with ſpirit of wine, as was done the firſt time, more and more ether will be obtained, and the maſs will never loſe its concentrative power."

municated to the Academy in 1742, is very ſimple, as it conſiſts only in mixing together ſpirit of wine and ſpirit of nitre in a bottle, which is to be exactly cloſed, and left at reſt, till the ether is formed and collected like an oil upon the ſurface of the liquor. This ether is made, as we ſee, without diſtillation.

Since Mr. Navier has publiſhed his diſcovery, other chemiſts have endeavoured to improve the proceſs. A very good proceſs is publiſhed in the Encyclopedia, which is attributed to Mr. Rouelle. Mr. Beaumé alſo has publiſhed one in his Diſſertation on Ether, which is very accurate, and is the reſult of many trials and reſearches. Mr. Beaumé's proceſs is as follows.

Put ſix ounces of rectified ſpirit of wine into a bottle made of ſtrong and thick glaſs, large enough to contain a pound of water. Place this bottle in a bucket of freſh water, which will be ſtill better for the purpoſe, if it has been rendered colder by throwing into it two or three pounds of ice, in ſmall bits. Pour upon the ſpirit of wine, at four or five times, four ounces of ſmoking ſpirit of nitre, ſo concentrated, that a phial, capable of containing an ounce only of water, ſhall be capable of containing an ounce and a half of this ſpirit of nitre: obſerving, during the whole time of pouring the ſpirit of nitre, that the ſpirit of wine be kept in a ſtate of perpetual rotation. As ſoon as the two liquors are mixed, ſtop the bottle quickly with a good cork, which muſt be driven firmly into the neck of the bottle, and covered and faſtened with a piece of leather doubled, and bound with packthread. Leave it at reſt in the cold water, which ought to be ſometimes renewed.

Two or three hours afterwards, the liquor loſes ſome of its tranſparency by the interpoſition of many ſmall drops of ether, which are diſengaged throughout the liquor. This ether gradually collects and floats upon the ſurface. Within twenty-four hours the mixture will have become clear; and the ether formed, which will be about two ounces, may be ſeparated. But as more ether will ſtill be produced, the method is to leave it ſeven or eight days before any of it be ſeparated. After this time no more ether is formed. Pierce then the cork with a pointed inſtrument; and a conſiderable quantity of air will eſcape with a hiſſing noiſe, which had diſengaged itſelf during the production of the ether, and which is compreſſed in the bottle. When the air has eſcaped, uncork the bottle, and pour quickly its contents into a glaſs funnel, that the ether may be ſeparated.

The ether will amount to about four ounces, and the reſiduum will weigh five ounces and a half; ſo that half an ounce ſhall have been loſt during the proceſs. This ether ought to be put into a well cloſed cryſtal-glaſs bottle. (t)

Nitrous ether in this ſtate has a ſmell like that of the vitriolic ether, but ſomewhat ſtronger and leſs agreeable. It has a light citron color; and as ſoon as the bottle which contains it is uncorked, it bubbles and effervesces. When the ſtopper is put in looſely into the neck of the bottle, it may be obſerved to riſe and fall alternately, which appearance is occaſioned by vapors eſcaping from the ether. The cauſe of theſe phenomena is a conſiderable quantity of air which remains interpoſed betwixt the parts of ether; for when all this air has been once diſengaged from the ether, theſe phenomena do not happen.

Nitrous ether is not, in this ſtate, pure; as it retains ſome of the acid employed, from which it may be purified by mixing it with ſome fixed alkali, and rectifying it with a lamp-heat. In this rectification, it ſuffers a loſs of nearly one half its quantity.

The properties of this rectified nitrous ether are, that it burns with a more luminous flame than the flame of vitriolic ether; that this flame is accompanied with a more ſenſible quantity of ſoot; that after the ether is burnt, a reſiduum of coal is perceptible; and, laſtly, that if it be evaporated on the ſurface of water in open air, it leaves upon the water ſome oil, as the vitriolic ether does, but in a little larger quantity. In other reſpects, but in theſe which ſhew that the nitrous ether is of a more oily nature than the vitriolic, theſe two ethers are perfectly ſimilar.

(t) Mr. Woulfe deſcribes an apparatus by which nitrous ether may be expeditiouſly obtained by diſtillation with the heat only occaſioned by mixing together the nitrous acid and the ſpirit of wine. This diſtillation is performed in a matraſs with a high neck, to which is fitted a head, with a ſpout, communicating with the receiver by means of a long tube. The vapors that are not condenſed in this receiver, or in a bottle joined to a ſpout in its bottom, are conveyed from the receiver through a bent tube into ſpirit of wine contained in a bottle. If any vapors paſs uncondenſed through this ſpirit of wine, they are conveyed through another bent tube into more ſpirit of wine contained in another bottle. The liquor collected in the bottle annexed to the receiver being ſlowly rectified with ſlaked lime, furniſhes very fine ether. The ſpirit of wine in which the vapors were condenſed, contains ſo much ether, that this fluid may be ſeparated from the ſpirit by adding water. This ſpirit of wine is by the operation changed into good dulcified ſpirit of nitre. *See the Phil. Tranſ. vol.* 5.

The activity and violence with which nitrous acid acts upon the ſpirit of wine is the moſt remarkable circumſtance of this operation. The action of nitrous acid is ſo much ſtronger than that of vitriolic acid upon ſpirit of wine, that equal parts of concentrated nitrous acid and ſpirit of wine cannot be mixed and contained: for nowithanding all the precautions that can be taken to moderate the action of theſe two liquors upon each other, they mix with ſo much violence when that proportion is uſed, that the mixture is inſtantly heated almoſt to inflammation, is reduced to vapors, and burſts the veſſels with a terrible exploſion.

In Mr. Beaumé's Diſſertation upon Ether, an account of the trials which he made upon this ſubject, and of the reſulting phenomena, may be ſeen.

In the ſecond place, when ſpirit of wine and nitrous acid are mixed in proper proportions, ether may be obtained without diſtillation; which is peculiar to this acid. The effects peculiar to the nitrous acid, in the preparation of ether, are cauſed by the action which this acid has, not only on the watery principle, but alſo on the inflammable principle of the ſpirit of wine. We have therefore reaſon to believe that nitrous acid converts ſpirit of wine into ether, not only by depriving it of its watery principle, but alſo by acting upon its inflammable principle with which it combines, or to which perhaps it joins its own inflammable principle. This is ſo true, that nitrous ether may be made with a nitrous acid which does not ſmoke, and which is, in ſome meaſure, ſaturated with water. For this purpoſe, a larger proportion of ſpirit of wine ought to be added. But if nitrous acid converted ſpirit of wine into ether, merely by depriving it of its watery principle, a diluted acid ought not to have the ſame effect as a ſmoking and concentrated acid, particularly as it cannot concentrate itſelf during the operation, ſince this is performed without diſtillation. Beſides, as nitrous acid has a greater affinity than any other with the inflammable principle, and contains a greater quantity of it, we ought not to be ſurprized that nitrous ether is produced without diſtillation, and more eaſily than any other.

Marine acid, on the contrary, having the leaſt diſpoſition of all the acids to unite with the inflammable principle, and ſeeming to contain leſs of it than any other acid, does therefore produce ether with moſt difficulty; or, properly ſpeaking, does not produce any ether, when pure, but only when it has been combined with metallic ſubſtances, as tin and antimony; part of the phlogiſton of which it may have acquired. *See* ETHER (MARINE). It probably becomes more proper to combine with the inflammable principle of the ſpirit of wine, or to communicate that which it has received, after it has already begun to unite itſelf with the inflammable principle of metallic matters.

From theſe conſiderations we are inclined to believe, that in the production of ether, the acids act at the ſame time upon the watery and inflammable principles of the ſpirit of wine, by depriving this ſpirit of the former, and by combining partly with the latter; or by encreaſing its proportion of acid, and thereby approximating it to an oily nature.

All acids, and particularly mineral acids, ſuffer ſingular alterations, and even tranſmutations, when they are diſtilled to dryneſs with a ſufficient quantity of ſpirit of wine. Mr. Pott, in his Diſſertation on the Vinous Acid of Nitre, ſays, that this acid by being combined with ſpirit of wine loſes the diſagreeable ſmell peculiar to it, and acquires a penetrating and agreeable ſmell; that it does not riſe in form of red vapors; but that it riſes with a leſs degree of heat than when pure, and that it acts leſs powerfully on fixed alkalis and abſorbent earths. He adds, that by diſtilling this mixture, oil and a reſiduous coal may be obtained: and that if nitrous acid previouſly combined with ſpirit of wine be ſaturated with a fixed alkali, a ſalt is formed which does not detonate like nitre, but burns like an oily ſalt, without waſte or diminution.

Pott reaſonably thinks, that this experiment may ſuggeſt hints concerning the tranſmutation of acids, and he believes that the nitrous acid, in that experiment, loſes its detonating and other eſſential qualities; becauſe the phlogiſton which enters its compoſition as a principle, is joined and confounded with the inflammable matter of the ſpirit of wine. The marine acid ſeems to ſuffer leſs alteration in combining with ſpirit of wine; for Mr. Pott ſays alſo, in his Diſſertation on the Vinous Acid of Salt, that having ſaturated with an alkali ſome marine acid, previouſly treated with ſpirit of wine, he obtained a regenerated common ſalt, which poſſeſſed all the eſſential properties of common ſalt. Nevertheleſs, Mr. Pott, having diſtilled to dryneſs the thick matter which remains after the moſt fluid and volatile part had been diſtilled from a mixture of marine acid and ſpirit of wine, obtained a reſiduous black fixed coal: which proves that one part of the acid of ſalt contracts in this experiment a very intimate union with the principles of ſpirit of wine; for the marine acid and ſpirit of wine diſtilled ſingly do certainly not leave any reſiduum.

ETHIOPS (MARTIAL). Martial ethiops is iron divided into exceedingly fine parts by the action of water.

This preparation was introduced into medicine by the younger Lemeri, who called it *ethiops* from its black color. To make ethiops, filings of iron are taken, very clean and free from ruſt, and are put into a glaſs veſſel; on theſe pure water is to be poured, to the height of three or four fingers thickneſs above the filings; the filings are to be frequently ſtirred with a ſpatula, till they become ſo fine a powder, that when agitated they remain long ſuſpended in the water: the water, thus rendered turbid by the ſuſpended powder of iron, is to be decanted; and the ſediment which is depoſited is to be dried and ground on a porphyry. This is the martial ethiops.

Iron is a metal which is ſoluble in many menſtruums. Its ſurface is ſenſibly affected by the combined action of air and water, and is in ſome meaſure corroded. It is thereby deprived of part of its inflammable principle, and partly reduced to an earth or calx, called *ruſt:* but to produce this effect, theſe two elements muſt concur: for iron is not ruſted nor altered by expoſure to dry air, or to water alone, without contact of air. *(u)*

Nevertheleſs, the operation of ethiops martial ſhows that water alone, without the concurrence of air, is capable of a certain action upon iron; ſince this metal is, by this action continued ſome time, reduced to parts exceedingly ſmall.

(u) Iron is not ſo readily ruſted when kept immerſed in water, as when it is firſt moiſtened and then expoſed to air; but it is nevertheleſs ſubject to ruſt if it be kept a few days under water, as thoſe workmen know who have occaſion frequently to keep pieces of iron under water, to ſoften and render the metal more ductile, and alſo to preſerve the ſurface from ruſt during a ſhort time. When they have occaſion to preſerve iron from ruſt a longer time, they immerſe it in lime-water, which being free from gas, is not ſo apt to ruſt iron as other waters are.

Whether this effect is cauſed by ſome heterogeneous particles in the water or in the iron, has not yet been determined. The iron thus reduced into martial ethiops is certainly very different from ruſt: It is black, attractable by magnets, and ſoluble in all acids; which proves that it is not deprived of its inflammable principle. Ruſt, on the contrary, has none of theſe qualities.

Theſe properties of martial ethiops have induced ſome perſons to propoſe it as a remedy much ſuperior to other preparations of iron. This manner of preparing iron for medicinal purpoſes is certainly good and unexceptionable; but Mr. Lemeri certainly ought not to have declaimed againſt all other preparations of iron indiſcriminately, nor to have adviſed their total diſuſe in medicine. He pronounced this general proſcription without ſufficiently underſtanding the matter. He would probably have been more indulgent, if he had known that ſeveral martial ſaffrons, ſuch as thoſe called aperitive, and which are nothing but ruſt, are capable of eaſily reſuming, and by the humid way all the phlogiſton which is neceſſary to reſtore to them all the properties of martial ethiops; and that this change is actually produced upon them when they are taken internally, by the fat matters which they meet in the ſtomach, in the inteſtines, and in the aliments and digeſtive juices. This is proved by the blackneſs of the excrements of thoſe who have taken theſe martial ſaffrons.

Mr. Lemeri had certainly not examined the nature of the precipitates obtained from ſolutions of iron in acids, and particularly in the vitriolic and marine acids, by a phlogiſticated alkali; for he muſt have obſerved, that ſuch precipitates receive from the alkali a ſufficient quantity of phlogiſton to give it a dark and blackiſh color, and to render it ſoluble in any acid: conſequently theſe precipitates, which are at leaſt as fine as the martial ethiops, are alſo equal to it in ſolubility, and preferable from the greater facility of their preparation.

When well phlogiſticated precipitates are required, they ought to be dried in cloſe veſſels, and by diſtillation. This is an operation which is alſo neceſſary for martial ethiops, although the author does not direct it; for the iron, being moiſt and much divided, ruſts with the greateſt facility from the contact of air.

Martial ethiops, and the martial precipitates and ſaffrons above-mentioned, are ſucceſsfully employed in medicine as excellent tonic and fortifying remedies. *See upon this ſubject* IRON.

ETHIOPS MINERAL. Ethiops mineral is a combination of mercury with a ſufficiently large quantity of ſulphur. The color of this compound is black, and hence it has been named ethiops.

Ethiops mineral may be made either by fuſion, or by trituration without fuſion.

To make ethiops mineral by fuſion: To ſulphur melted in an unvarniſhed earthen veſſel, an equal quantity of very pure mercury is to be added; the veſſel is at the ſame time to be taken from the fire, and the mixture is to be ſtirred with a ſpatula till it be cold and fixed; the mixture is then become a black and friable maſs, which is to be pounded and ſifted. This is ethiops.

To make this preparation without fire, two parts of mercury are triturated in a glaſs or marble mortar with three parts of flowers of ſulphur, till the mercury no longer appears.

Mercury and ſulphur have a ſtrong diſpoſition to unite together. For this purpoſe, their integrant parts muſt be made to touch, and then they contract an adheſion, but not ſo ſtrong as that which they acquire by ſublimation in the proceſs for making cinnabar.

The black color of ethiops is always taken by mercury, when it is much divided and mixed with inflammable matters. In this reſpect it reſembles ſilver, lead, and other metals, which acquire a black color from the ſuperficial union which they contract with ſulphur or other phlogiſtic matters.

Although the union of mercury with ſulphur in ethiops is not ſo ſtrong as in cinnabar, we muſt not believe that in ethiops theſe two ſubſtances are not united, but only mixed and interpoſed; for they really adhere and are combined together. The proof of this is, that they cannot be ſeparated from each other without intermediate ſubſtances. Theſe ſubſtances are the ſame as thoſe which are capable of procuring a ſimilar ſeparation by decompoſing cinnabar. *See* CINNABAR.

The difference betwixt ethiops prepared by fuſion, and ethiops prepared by trituration is, that the former contains a leſs quantity of ſulphur than the latter.

Mr. Lemeri has obſerved, in his Courſe of Chemiſtry, that when ethiops is made with fire, one half of the ſubſtances employed is loſt; but the proportion in which each of the ſubſtances is diſſipated is not known: we are, however, certain, that more ſulphur is loſt than mercury; notwithſtanding which, each kind of ethiops contains more ſulphur than is neceſſary for the ſaturation of the mercury, as evidently appears from the operation of making artificial cinnabar.

The chief uſe of ethiops mineral is in medicine. It may be given from ſix grains to half a dram, incorporated with other ſuitable remedies. It is employed as a reſolvent in the aſthma, ſcrophula, obſtructions and diſeaſes proceeding from a ſtoppage or thickneſs of humours. Some phyſicians preſcribe it in venereal diſeaſes: others affirm, that ethiops has no medicinal virtue: however, it certainly occaſions ſalivation ſometimes, although ſeldom. *See* MERCURY.

EVAPORATION. Evaporation is a chemical operation, by which, with a certain degree of heat and acceſs of air, volatile ſubſtances are ſeparated from others leſs volatile.

The effect of evaporation is eſſentially the ſame as that of diſtillation, with this difference, that diſtillation is almoſt always employed to ſeparate and collect a volatile ſubſtance; whereas evaporation is always employed to ſeparate and collect the fixed or leſs volatile ſubſtance only, the more volatile part being neceſſarily loſt in the operation.

Evaporation is always made in open air, and with open veſſels; for air contributes much to the volatiliſation of bodies, and evaporation is only performed from their ſurfaces: hence the general rules for evaporation are, to place the body from which volatile parts are to be evaporated in a flat, ſhallow, wide veſſel, ſo that it ſhall preſent to the air a large ſurface, towards which even a current of air ought to be directed.

In all evaporations the degree of heat ought to be proportioned to the volatility of the ſubſtance to be evaporated, and ſtill more to the degree of fixity of the ſubſtance intended to be left, and of its adheſion to the volatile parts. Thus, the leſs fixed the remaining ſubſtance is, and the more ſtrongly it adheres to the volatile ſubſtance, the leſs the heat ought to be. For inſtance, if we would obtain the portion of oil which is found in rectified ſpirit of wine and ether, theſe liquors ought to be evaporated, as Mr. Beaumé did, upon the ſurface of water in open air, and without any other heat than that of the atmoſphere; for, however little the evaporation of theſe liquors is urged by a heat a heat ſomewhat too ſtrong, the volatility of this ſmall portion of oil differs ſo little from that of ſpirit of wine and of ether, that it would entirely exhale with theſe liquors without any ſeparation, as it does when they are rectified. Thus Mr. Duhamel having diſcovered, by his experiments, that the volatile alkali of ſal ammoniac carries off with it a conſiderable portion of the fixed earthy intermediate ſubſtances employed to diſengage it, could not afterwards ſeparate this earthy part from the concrete volatile alkali, but by allowing this latter to diſſipate itſelf by the heat alone of the air, and by an evaporation which continued ſeveral months; becauſe this earthy part, although very fixed, is ſo well combined, and adheres ſo ſtrongly to volatile alkali, that it is always carried along with the ſalt in evaporation, whenever the heat exceeds that of the atmoſphere. *See Mr. Duhamel's Memoirs concerning Sal Ammoniac amongſt the Memoirs of the Academy.*

On the contrary, in ſome caſes evaporation may be urged by a ſtrong heat, and even by a current of air directed upon the ſurface of the body. This is practiſed when the part to be evaporated is not very volatile, and requires conſiderable heat to raiſe it, and when the remaining ſubſtance is very fixed, and does not adhere much to the volatile part. Such, for example, is the evaporation of regulus of antimony in the *purification of gold by antimony. See that operation.*

The veſſels employed in evaporation are baſons, teſts, crucibles; and theſe veſſels are made of glaſs, metal, or of earth, according to the nature of the bodies on which the operation is to be performed.

EUPHORBIUM. *(x)*

EXCREMENTS (LIQUID) *of* ANIMALS. *See* URINE.

EXCREMENTS (SOLID) *of* ANIMALS. Alchemiſts, who have ſought every where for their great work, as they called it, have particularly operated much on the excrements of men and other animals; but philoſophical chemiſtry has acquired no knowledge from all theſe alchemical labors, from the obſcurity with which their

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(*x*) EUPHORBIUM is a very acrid, gummy, reſinous juice. From an ounce of euphorbium five drams were extracted by ſpirit, and from another ounce five drams alſo were extracted by water. Both theſe extracts, but chiefly the ſpirituous, were acrid and corroſive. *Neuman* authors have deſcribed them. The philoſophic chemiſts have not much examined animal excrements. Of theſe, Homberg is the only one who has particularly analyſed and examined human ordure; and this was done to ſatisfy an alchemical project of one of his friends, who pretended that from this matter a white oil could be obtained, without ſmell, and capable of fixing mercury into ſilver. The oil was found by Homberg, but mercury was not fixed by it.

The labors of this able chemiſt were not however uſeleſs, like thoſe of the alchemiſts, becauſe he has clearly related the experiments he made on this matter, in the Memoirs of the Academy of Sciences. Theſe experiments are curious, and teach ſeveral eſſential things concerning the nature of excrements. The reſult of theſe experiments is as follows.

Freſh human fœces, being diſtilled to dryneſs in a water-bath, furniſh a clear, watery, inſipid liquor, of a diſagreeable ſmell, but which contains no volatile alkali; which is a proof that this matter, although nearly in a putrefactive ſtate, is not however putrefied; for all ſubſtances really putrid furniſh with this degree of heat a manifeſt volatile alkali. *See* PUTREFACTION.

The dry reſiduum of the foregoing experiment, being diſtilled in a retort with a graduated fire, furniſhes volatile alkaline ſpirit and ſalt, a fetid oil, and leaves a reſiduous coal. Theſe are the ſame ſubſtances which are obtained from all animal matters. *See* SUBSTANCES (ANIMAL).

Human fœces, diluted and lixiviated in water, furniſh by filtration and evaporation of the water an oily ſalt of nitrous nature, which deflagrates like nitre upon ardent coals, and which inflames in cloſe veſſels, when heated to a certain degree.

This ſame matter yielded to Homberg, who treated it by a compleat fermentation or putrefaction, excited by a digeſtion during forty days in a gentle water-bath heat, and who afterwards diſtilled it, an oil without color, and without bad ſmell, and ſuch as he endeavoured to find; but which did not, as we ſaid before, fix mercury into ſilver.

EXPRESSION. Expreſſion is a mechanical operation, by which the juices of many plants are obtained; and ſweet oils, which are not volatile, may be extracted from many ſubſtances in which they reſide ſuperabundantly and uncombined. Such are all emulſive ſeeds, and ſome fruits, as oranges, citrons, lemons, olives, &c. An oil may alſo be obtained from yolks of eggs by expreſſion.

This operation is performed by putting the ſubſtance to be expreſſed, previouſly bruiſed, in a machine called a preſs.

The plants from which the juices are to be extracted, having been bruiſed in a mortar, ought to be wrapped up in a ſtrong and cloſely woven linen cloth, and then put into the preſs. The plants which are not very ſucculent, or too mucilaginous to give their juices by expreſſion, ought to be mixed with ſome water when they are bruiſed in a mortar.

Grains or ſeeds muſt alſo be bruiſed before they are expreſſed to obtain their oil, ſo as to form them into a greaſy paſte, the oil of which exſudes ſpontaneouſly. They are then to be wrapped in a ſtrong linen cloth, and expreſſed. To obtain as much oil as is poſſible, this paſte ought to be expreſſed betwixt two hot iron plates. But this method renders oils rancid, and therefore ought not to be uſed in the preparation of oils for medicinal purpoſes.

To obtain oil from yolks of eggs by expreſſion, they ought previouſly to be hardened by baking, or even a ſlight torrefaction. *See* JUICES (EXPRESSED), *and* OILS (SWEET).

EXTRACT. This word, taken in the moſt general ſenſe of which it is capable, is applicable to ſubſtances ſeparated from any compound body by a proper menſtruum. But it is generally confined to denote ſubſtances ſeparated from vegetables by water.

To make an extract from any vegetable ſubſtance, it muſt be infuſed or boiled in a ſufficient quantity of water, to extract from it all the ſubſtances ſoluble in this menſtruum. If the vegetable matter of which the extract is to be made is itſelf ſucculent and watery, it need not then be infuſed or boiled. The juice which contains all the matter of the extract may be expreſſed; for in this caſe, the water in the plant has the ſame effect as the water employed in infuſion or decoction.

Then the infuſion, decoction, or expreſſed juice of the plant muſt be evaporated till they acquire more or leſs firm conſiſtence. For ſome extracts are made as ſoft as paſte, and are called *ſoft extracts*; others are evaporated till they become dry, and are called *dry* or *ſolid extracts*.

The liquor from which the extract is to be made by evaporation is always more or leſs charged with feculent matters, earthy or reſinous, which render it turbid, becauſe theſe matters are not ſoluble in water. Theſe matters are generally ſeparated before the liquor is evaporated

porated to the conſiſtence of an extract, which may be done by clarification with the white of an egg, or otherwiſe. By this ſeparation of feculent matter, ſoft extracts are rendered leſs liable to ferment and to become mouldy. But as the intention of making an extract is to preſerve all that can be preſerved of the principles of plants, the liquor of the extract ought not to be clarified, but it ought to be evaporated till it becomes dry, and thereby rendered not ſubject to change.

As extracts ought to reſemble, as nearly as is poſſible, the vegetables from which they are obtained, they ought to be evaporated with a gentle heat, and in a water-bath; becauſe the delicate and compounded principles of vegetables are liable to be changed by a ſtrong heat. But to avoid the inconveniences attending a tedious evaporation, by which a fermentation of the matter might be induced, this evaporation may be accelerated by encreaſing the ſurface of the liquor, which therefore ought to be diſtributed in many flat and wide-mouthed veſſels. *See* EVAPORATION. In this manner the Count de la Garaye prepared what he called *eſſential ſalts*, which are nothing but ſolid extracts, the beſt and moſt perfect which can be obtained.

From what has been ſaid concerning extracts, we may conclude, that they are collections of the proximate principles of vegetables, and chiefly of thoſe which are ſoluble in water, and which are not ſo volatile as to be capable of diſſipation by the heat of boiling water. They contain, therefore, when well made, all the gummy, mucilaginous, ſaponaceous, (that is, the oil rendered ſoluble in water by ſome ſaline ſubſtance) bitter, or ſaccharine matters; and laſtly, all the eſſential ſalts, acid or others, or any other ſaline matters, which are contained in vegetables. In well made extracts are alſo found portions of the oily, reſinous, and earthy principles of vegetables, which, although inſoluble in water, have been extracted along with the other principles into the juice, infuſion, or decoction; excepting, for particular reaſons, theſe principles are required to be excluded. If extracts are required which ſhall poſſeſs as much as they can of the properties and virtues of plants, we ought not only to extract by water, but alſo by ſpirit of wine, and to mix together the ſubſtances thus extracted by theſe two menſtruums. *See* ANALYSIS *by* MENSTRUUMS.

The taſte of almoſt all extracts is bitter or ſaline, and ſomewhat like that which ſugar or other vegetable ſubſtances acquire by ſlight burning. But this latter quality is faulty. It proceeds from a too ſtrong heat having been employed to evaporate the extracts, by which ſome of the ſubſtances contained in the extract are conſiderably changed, or even deſtroyed.

Several dry extracts, or eſſential ſalts of the Count de la Garaye, attract moiſture from the air, and even become liquid. This property is occaſioned by a ſeparation of the ſaline from the reſinous and earthy parts of the vegetable, and which are therefore uncombined, and conſequently apt to attract moiſture.

Theſe extracts ought to be preſerved in well cloſed bottles.

EXTRACT (MARTIAL). This name is given to a pharmaceutical preparation, which is not, properly ſpeaking, an extract, ſince it is only a combination of iron with tartar, called *Tincture of Mars*, reduced to the conſiſtence of an extract. *See* TINCTURE *of* MARS.

FALSE GALENA. This is a mineral which reſembles at firſt view the lead ore called galena; but from which no metal is extracted. (y)

FALSE PRECIPITATE. This name is given to a matter which has the appearance of a precipitate, but which has not been ſeparated from a menſtruum. Such is mercury reduced into a red powder without addition, and merely by heat, improperly called *precipitate per ſe*, or mercury precipitated by itſelf: ſuch alſo is *red precipitate*, which is mercury diſſolved in ſpirit of nitre, and afterwards deprived of moſt of the acid by fire, without any intermediate ſubſtance. Silver, lead, mercury, ſeparated from nitrous acid by marine or vitriolic acids or ſalts, are alſo generally conſidered as precipitates, and are really ſo, as they are actually ſeparated from one ſubſtance by the intervention of another: but as this ſeparation is made by the union of the precipitated metal with the precipitating acid, ſuch precipitate ought to be diſtinguiſhed from thoſe which are nothing but the precipitated matter uncombined and ſingle. *See* PRECIPITATES *and* PRECIPITATION.

(y) FALSE GALENA. *Pſeudo Galena*, called alſo *Black-jack*, or *Blend*, is an ore of zinc, containing, beſides that ſemi-metal, generally ſome iron, together with the mineralizing ſubſtances ſulphur and arſenic. It is frequently intermixed with the lead ore called galena, and ſometimes with the cupreous pyrites. In England the former kind is found in the lead mines of Derbyſhire, and the latter in the copper mines of Cornwall. This mineral, formerly neglected as uſeleſs, has lately been employed, after a careful calcination, inſtead of calamine, for the manufacture of braſs; and might alſo be employed as calamine is, for the extraction of zinc. For theſe purpoſes, that kind of blend is fitteſt which contains moſt zinc, and leaſt of iron and arſenic. Such is the blend of Derbyſhire, which is a very rich ore of zinc. This kind is more laminated in its texture, and of a greyiſh color when ſcratched; whereas the blend found in Cornwall has a more teſſelated texture, conſiſting of oblong parallelipipedons, is of a reddiſh color when ſcratched, and contains a larger quantity of iron and arſenic.

FAT. Fat is an oily concrete ſubſtance, depoſited in different parts of animal bodies.

To obtain fat very pure, it muſt be cut into pieces, and cleaned from the interpoſed membranes and veſſels; it muſt then be cleanſed from its gelatinous matter by waſhing with water, till the water comes from it colorleſs and inſipid; it is afterwards to be melted with a moderate heat, in a proper veſſel, with a little water; and it is to be kept thus melted till the water be entirely evaporated, which is known by the diſcontinuance of the boiling, which is cauſed by the water only, and which laſts till not a drop of it remains: it is afterwards to be put into an earthen pot, where it fixes; then it is exceedingly white, ſufficiently pure for the purpoſes of pharmacy or chemical examination.

Fat thus purified has very little taſte, and a weak, but peculiar ſmell.

Mineral acids exhibit the ſame phenomena with fat, as they do with the fixed ſweet oils of vegetables, which contain nothing gummy or reſinous, and which do not dry. Such is the oil of ben, oil of olives, and all thoſe which chemiſts call *fat oils.*

Alkalis diſſolve fat, as they do theſe oils, and form a ſimilar ſoap. Fat contains no principle ſo volatile as to be raiſed with the heat of boiling water. It does not inflame but when heated in open air ſo as to riſe in vapors. Laſtly, by age it contracts an acrid and rancid quality.

When fat is diſtilled with a heat ſuperior to that of boiling water, which muſt therefore be done in a retort, and in a naked fire, firſt an acid phlegm ariſes, and a ſmall portion

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tion of oil which remains fluid. As the diſtillation continues, the acid becomes ſtronger, and the oil thicker, and at laſt it congeals in the receiver. No other principle ariſes during this diſtillation: and laſtly, when the retort is red, nothing remains but a very ſmall quantity of that kind of coal which cannot be burnt without very great difficulty. *See* Coal.

If the congealed oil which is found in the receiver be again diſtilled, more acid is obtained, and an oil which does not congeal; and thus, by repeating the diſtillations, the oil is more and more attenuated. While it is thus deprived of its acid, it acquires a more and more penetrating ſmell; and thus by diſtillation alone it may be rendered as volatile as eſſential oils, and capable of riſing with the heat of boiling water.

From all theſe properties of fat we may perceive it is a ſweet concrete oil, not volatile, and perfectly analogous to butter and wax; and that its conſiſtence, as well as the conſiſtence of theſe analogous ſubſtances, is cauſed by an acid intimately united with it, which cannot be ſeparated but gradually and by repeated diſtillations. Fat, and all other analogous oily matters, cannot be heated ſufficiently to be raiſed into vapors, without ſuffering a conſiderable alteration, and even decompoſition. The vapors which riſe from it, when heated in open air, are the ſame as thoſe which riſe when diſtilled in cloſe veſſels. They conſiſt of acid and attenuated oil. This acid is remarkably penetrating, acrid, and volatile; it irritates and inflames the eyes, the throat, and lungs; it makes the eyes ſhed tears, and excites a cough as much as volatile ſulphureous acid does, although its nature be very different.

When fat is in its natural ſtate, and has not yet ſuffered any alteration, its acid is ſo well combined with its oily part, that none of its properties can be perceived. Thus fat in good condition is very mild, and uſed ſucceſsfully in medicine, particularly externally, for its lenient quality: but, notwithſtanding its great mildneſs, before it has been heated ſufficiently to decompoſe it, and while it is yet freſh, it becomes exceedingly acrid, irritating, and cauſtic, when its acid is partly diſengaged by fire or by time.

When fat is become very rancid, not only its medicinal effects, but alſo many of its eſſential properties, are totally changed, particularly its property of reſiſting the action of ſpirit of wine: for this menſtruum, which does not affect pure and unchanged fat, diſſolves ſome portion of fat which has been ſtrongly heated, or which has become rancid. This effect can certainly proceed from no other cauſe, than that the acid of the fat diſengages itſelf in both theſe caſes. Mr. Macquer has ſhewn this in his Memoir concerning the Cauſe of the different Solubility of Oils in Spirit of Wine. We ſhall ſpeak more fully on this matter at the article OIL. Mr. De Machy, an intelligent apothecary of Paris, and an able chemiſt and obſerver, has made a remark upon this ſubject which correſponds with this opinion; which is, that all the rancidity of fat may be taken from it by treating it with ſpirit of wine. Now, this evidently happens, becauſe the ſpirit of wine diſſolves all the portion of fat which is diſengaged from its acid; that is, all the rancid part, while it does not touch that which is not changed. This practice may be advantageouſly employed for the preſervation or recovery of ſome fats uſed in medicine, but which are rare, and not to be procured in their recent ſtate.

The decompoſition of fat, from which may be obtained acid, oil, a very ſmall quantity of reſiduous coal, and not a particle of volatile alkali, proves evidently, that this ſubſtance, although elaborated in animal bodies, of which it makes a part, has not the marks of an animaliſed matter; it therefore ſeems to make a ſeparate claſs, and to be produced from the oily parts of the aliments which could not enter into the compoſition of the nutritive juices: it is conſequently an oil ſuperabundant to nutrition, which nature depoſites and reſerves for particular purpoſes. One of the chief uſes of fat probably is to receive into its compoſition, to blunt and correct a great part of the acids of the aliments, and which are more than are requiſite to the compoſition of the nutritive juice, or which nature could not otherwiſe expel. This is certain, that the greater the quantity of aliments is taken by healthy animals, above what is neceſſary for their nouriſhment and reproduction, the fatter they become. Hence animals which are caſtrated, which are not much exerciſed, or which are come to an age when the loſs and production of the ſeminal fluid is leſs, and which, at the ſame time, conſume much ſucculent aliment, generally become fatter, and ſometimes exceedingly ſo.

Although fat be very different from truly animaliſed ſubſtances, and appears not eaſily convertible into nutritive juices, it being generally difficult of digeſtion, and apt to become rancid, as butter does in the ſtomachs of many perſons; yet in certain caſes it ſerves to the nouriſhment and reparation of the body. Animals certainly become lean, and live upon their fat, when they have too little food, and when they have diſeaſes which prevent digeſtion and production of the nutritive juice; and in theſe caſes the fatter animals hold out longer than the leaner. The fat appears to be then abſorbed by the veſſels deſigned for this uſe, and to be transformed into nutritive juice.

The fats of different animals differ little. They have all the ſame eſſential properties, and only vary ſenſibly in conſiſtence. Frugivorous animals, and particularly ſheep, have very firm fat; moſt reptiles, and particularly fiſh, which are almoſt all carnivorous, have a ſoft and ſometimes a liquid fat. *See* BUTTER, WAX, *and* OIL.

FEATHERS. *(z)*

FENNEL. *(a)*

FENUGREEK. *(b)*

FERMENT. A ferment is a ſubſtance actually fermenting, or ſtrongly diſpoſed to ferment, and which is employed to determine and excite another body to fermentation; ſuch are yeaſt, leaven, and other ſuch ſubſtances. *See* FERMENTATION.

FERMENTATION. Fermentation is an inteſtine motion, excited ſpontaneouſly, with the aſſiſtance of proper heat and fluidity, betwixt the integrant and conſtituent parts of certain very compound bodies, from which reſult new combinations of the principles of theſe bodies.

All vegetable and animal matters, into the compoſition of which enter a certain quantity of fluid oil and earth, rendered perfectly ſoluble in water by the intervention of a ſaline matter, being diffuſed in a ſufficient quantity of water

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(z) FEATHERS. From ſixteen ounces of feathers Neuman obtained ſix ounces two drams of ſpirit, two ounces and two drams of ſalt, one ounce two drams of oil, and a reſiduum, from which, after calcination, twenty-ſix grains of ſaline matter were elixated.

(a) FENNEL. The leaves and ſeeds of common fennel contain an eſſential oil. The oil obtained from the leaves on the upper part of the plant is much finer, lighter, and more ſubtle than the oil obtained from the lower leaves. The former oil ſwims on water, and the latter oil ſinks. *Neuman.*

(b) FENUGREEK. The ſeeds of this plant contain an expreſſible oil blended with reſin and mucilage, but no eſſential oil. From ſixteen ounces, eleven drams were extracted by water; and from the ſame quantity, four drams and a half were extracted by ſpirit of wine. *Neuman.*

water to become liquid, or at leaſt ſoft, and being expoſed to heat from a few degrees above the freezing point to twenty-five and more, and when the communication with air is not entirely ſtopt, ſuffer ſpontaneouſly the fermentative motion, which entirely changes the nature and proportion of their principles.

But this fermentation, and the new compounds produced by it, differ conſiderably both in properties and proportions, according to the nature of the fermented ſubſtance, and the circumſtances of the fermentation.

We may diſtinguiſh three particular kinds of fermentation, or three degrees of the ſame fermentation, which refer to the three principal products which reſult from it.

The firſt is called *vinous* or *ſpirituous fermentation*; becauſe it changes into wine the liquors which undergo it, and becauſe from this wine may be obtained an inflammable ſpirit, miſcible with water, called *ſpirit of wine*.

The ſecond kind of fermentation is called *acid* or *acetous*, becauſe the product of it is an acid, or *vinegar*.

The third fermentation is called the *putrid* or *putrefactive*. It might alſo be called the *alkaline* fermentation, becauſe much alkali is diſengaged by it.

All matters ſuſceptible of the ſpirituous fermentation may afterwards undergo the acid, and, laſtly, the putrid fermentation; but ſome ſubſtances are not ſuſceptible of the ſpirituous fermentation, but proceed firſt to the acid, and afterwards to the alkaline or putrid fermentation; and laſtly, ſome ſubſtances are ſuſceptible of the putrid fermentation only. Further, a ſubſtance which having undergone the ſpirituous fermentation, has proceeded to the acid fermentation, cannot be again made to undergo the ſpirituous, but paſſes neceſſarily to the putrid. Alſo thoſe ſubſtances which have undergone the acid fermentation directly, that is, without previouſly paſſing through the ſpirituous, are only then ſuſceptible of the putrid, and not of the ſpirituous fermentation; and the ſubſtances which paſs directly to the putrefactive fermentation cannot be made to undergo, at leaſt ſenſibly, the acid, and ſtill leſs the ſpirituous fermentation. Laſtly, any matter ſuſceptible of the ſpirituous fermentation cannot be made to putrify without previouſly paſſing through the ſpirituous and acid fermentations.

Theſe conſiderations have induced moſt chemiſts, and particularly the great Stahl, to conſider theſe fermentations leſs as three operations diſtinct and independant of each other, than as three principal and diſtinguiſhed degrees of one and the ſame fermentative motion, by which nature endeavours to reſolve, and to reduce into a ſimilar condition, all the moſt compounded bodies, into the combination of which enters the oily principle; that is, all animal and vegetable ſubſtances.

We may add, that while vegetable and animal ſubſtances, ſuſceptible of fermentation, make part of the living vegetable or animal, they undergo fermentation only in a ſlow and inſenſible manner; becauſe they are preſerved from it by the vital motion, and becauſe this ſlowneſs is neceſſary for the vegetable and animal economy: but when the life of organiſed bodies ceaſes, then, as nothing in their juices or proximate principles prevents their diſpoſition to change their nature and to be decompoſed, all theſe ſubſtances ſenſibly acquire the fermentative motion, and paſs with more or leſs rapidity and regularity through the periods of change which they have ſtill to undergo, according to the concurrence of circumſtances which generally favor fermentation.

According to this idea, fermentation, taking it altogether, would be nothing elſe than putrefaction; to which all animals and vegetables naturally and continually tend, during their life, ſlowly and inſenſibly; but after their death, quickly and ſenſibly.

At the beginning of this article, we obſerved what the neceſſary conditions were for fermentation of any body, and hence the means by which it may be prevented or ſuſpended are eaſily deduced. Theſe means are, intenſe cold, want of air and of water, and laſtly, a diſproportion of the principles of the body expoſed to fermentation.

The moſt fermentable liquors, as the juices of grapes and other ripe fruits, do not ferment when expoſed to too great cold. The blood and fleſh of animals are preſerved from corruption by froſt. They may be alſo preſerved under the exhauſted receiver of an air-pump, or by drying perfectly. They may particularly be preſerved by this latter method any time, without ſuffering the leaſt alteration.

We are to remark, upon this ſubject of preventing fermentations in fermentable ſubſtances, that when only the neceſſary degree of heat is employed to deprive them of their ſuperabundant moiſture, and their compoſition conſequently is not changed; we may, by mixing them again with the proper quantity of water, reſtore to them the ſame tendency to ferment which they had before they were dried. This obſervation is particularly applicable to matters ſuſceptible of the firſt and laſt degrees of fermentation; and we ought to conclude from thence, that although the products of the ſpirituous and alkaline fermentation are more volatile than water, yet the fermentable ſubſtances contain no principle which is not leſs volatile than water.

The laſt method of preventing or retarding fermentation in fermentable ſubſtances is, as we ſaid, to change the proportion of their proximate principles, which is conveniently done by mixing them with ſome ſubſtance which can unite itſelf to theſe principles, and which is not itſelf fermentable; ſuch are ſpirit of wine, acids, and even all ſaline ſubſtances. For this reaſon wine is preſerved in the ſame ſtate by penetrating it with ſulphureous acid; and alſo animal matters are preſerved from corruption by mixing them with ſpirit of wine, common ſalt, or any other ſalts.

Thoſe vegetable and animal ſubſtances only are properly fermentable which contain oil. The action of minerals, or of their principles on each other, nor even the action of decompounded vegetable and animal ſubſtances, can be conſidered as true fermentations, except we ſo far extend the meaning of the word fermentation as to include the ſpontaneous and inteſtine motion of decompounding pyrites, by which new ſalts are formed; the changes produced upon the imperfect metals by air and by water; the rancidity of oils; and other changes, which appear to differ eſſentially from the fermentation of animal and vegetable matters.

The effervеſcences which happen betwixt bodies not much compounded, when they mutually diſſolve each other, ſuch as the effervеſcences perceived when acids unite with earths, alkalis, or metals, are much more different from true fermentation, and have never been confounded together but by perſons entirely ignorant of chemiſtry.

We may judge from what we have ſaid concerning fermentation in general, how important this matter is for the attainment of a knowledge of animal and vegetable ſubſtances; but we cannot form an adequate notion of it, without conſidering attentively the particular phenomena which appear in the ſeveral kinds or degrees of fermentation. Wherefore, upon this, the articles KINGDOM (VEGETABLE), KINGDOM (ANIMAL), WINE, SPIRIT *of* WINE, TARTAR, VINEGAR, *and* PUTREFACTION, may be conſulted.

FILTRATION *and* FILTERS. Filtration is an operation by which the heterogeneous parts mixed with a liquor a liquor are ſeparated, or by which certain matters are freed from an uſeleſs liquid. Filtration is generally performed by means of filters. A heap of ſmall parts of any ſubſtance, as ſand, may alſo be employed for filtration in ſome caſes.

The rules of filtration are very ſimple. The chief of theſe are, that the filter ſhall contain nothing which the liquor that paſſes through is capable of diſſolving; that it ſhall not be liable to be attacked or corroded by the liquor; and that its pores ſhall be ſmaller than the particles of the matter to be ſeparated from the liquor.

A liquor cannot be filtrated, unleſs its fluidity and thinneſs be proportioned to the pores of the filter. Liquors which are viſcid and thick, as ſyrups and mucilages, and thoſe which are very thick, as very ſtrong ſolutions of ſome ſalts, do not paſs, or with great difficulty, through filters, whoſe pores appear otherwiſe ſufficiently large in proportion to the fineneſs of their parts. This proceeds from the adheſion which theſe parts have to each other.

The filtration of theſe liquors is generally much forwarded by heat. Strong ſolutions, for inſtance, of ſalts, large proportions of which are ſoluble in water, as nitre, Glauber's ſalt, and others, require to be filtrated when boiling hot.

When the parts of a matter diffuſed in this liquor adhere to this liquor, they cannot be ſeparated by filtration. This adheſion muſt be previouſly deſtroyed. For inſtance, the expreſſed juices of plants are impregnated with a reſinous, earthy, fine matter, adhering to theſe juices, and deſtroying their tranſparency. The whey of milk alſo is turbid from the many fine caſeous parts adhering to it. Theſe liquors cannot be clarified by filtration without a previous preparation; for they cannot paſs through the pores of a filter cloſe enough to retain the heterogeneous particles which diſturb their tranſparency; and through a filter open enough to give them paſſage, they would paſs in their turbid ſtate.

Such liquors are rendered capable of filtration by coagulating and collecting the heterogeneous parts. This is effected by boiling, and ſtill better by whites of eggs mixed and boiled together with theſe turbid liquors. Whites of eggs, when they coagulate, collect and agglutinate the heterogeneous parts, which then appear in larger molecules, and float freely in the liquor without adhering to it. This liquor is then in a ſtate of filtration; it paſſes clear, and the matter which rendered it turbid remains upon the filter. The fine caſeous parts which diſturbed the tranſparency of whey are ſo well mixed in it, that, beſides whites of eggs, ſome cream of tartar muſt be added, to procure the required coagulation.

The matters generally uſed as filters are woollen ſtuffs, linen cloths more or leſs fine, and brown paper. The form of filters varies according to the quality and quantity of the matters to be filtrated. Some of them are hollow inverted cones. Theſe are more uſed in pharmacy and cookery than in chemiſtry. With theſe ſyrups are filtered. The filter moſt frequently uſed in chemiſtry is paper, in the making of which no paſte or ſize has been employed.

When a ſmall quantity only of matter is to be filtrated, the paper muſt be folded ſo as to take the form of a funnel, and to be placed in a glaſs funnel, with ſtraw interpoſed betwixt the filter and the ſides of the funnel, to prevent the filter from applying itſelf immediately and in all its extent to the funnel, when it is filled and wet.

When much matter is to be filtrated, a cloth is to be fixed to the four corners of a wooden frame, ſo that it ſhall not be ſtretched tight: to the cloth is fitted paper, upon which the liquor is to be poured.

The firſt portions of liquors which paſs in filtration are almoſt always more or leſs turbid; wherefore they ought to be poured again upon the filter, and even more than once till it paſſes perfectly clear. This happens becauſe the pores of the filter, at firſt too open, are afterwards contracted by the ſwelling occaſioned by the liquor, or they are partly ſtopped up by the ſediment which is depoſited upon them.

FIRE. Chemiſts conſider fire, as alſo the other elements, in two very different views: firſt, as it enters into the compoſition of many bodies, of which it is a principal or conſtituent part; and ſecondly, as being pure, free, not entering into any compound, but acting ſenſibly and ſtrongly upon all natural bodies, and producing effects as a powerful agent in all chemical operations. In this latter point of view we ſhall conſider fire in this article. It will be conſidered as a principle under the article PHLOGISTON.

Pure, free, uncombined fire ſeems to be a collection of particles, the matter of which is ſimple, homogeneous, and entirely unalterable. All the properties of this element ſhew that its particles are infinitely ſmall, have no ſenſible adheſion to each other, and that they have a very rapid, continual motion in all directions, which is eſſential to them.

From this definition, fire appears to be a body eſſentially fluid, and many facts concur to prove that it is the only body eſſentially fluid, conſequently the cauſe of the fluidity of other bodies; and that as it alone counterbalances the general tendency of all the other parts of matter towards each other, they are prevented by it from uniting into one immenſe, homogeneous, and perfectly hard maſs.

Whence can ſo aſtoniſhing a difference proceed between the properties of the primitive integrant molecules of fire, and thoſe of the integrant parts of all other matter? Is fire then not material, or not compoſed of matter, as its properties have induced ſome philoſophers to think? Is it matter of a peculiar kind? Or does, as a great geometrician thinks, the attraction of the parts of matter become negative, and changed into repulſion, when theſe parts become infinitely ſmall, and can come infinitely near to each other; which ſeems very probably to be the caſe with the particles of fire?

We have not facts enough to decide concerning theſe different opinions. We ſhall, therefore, confine ourſelves to inveſtigate the eſſential properties of fire, chiefly thoſe which influence moſt in chemical operations and chemical phenomena.

Fire can with great facility penetrate, or ſeparate itſelf from, any body however denſe; that is, any body whatever may be heated by expoſure to fire; or cooled to its former temperature, by removing it from this expoſure.

From this effect we may infer the infinite ſmallneſs of the integrant parts of fire; and we may perceive the cauſe of its equal diſtribution through all bodies, when it is not determined by ſome particular cauſe to penetrate one body in greater quantity than another.

In fact, all ſubſtances whatever, which are placed in any given degree of heat, and obliged to remain there, acquire preciſely the ſame degree of heat. This fact has been aſcertained by inſtruments fit for meaſuring the degrees of heat.

The effects which the fire produces, or rather heated bodies, upon our ſenſes, are ſenſations of heat and light; but theſe ſenſations are not excited but when the fire is in a certain quantity; for every known body contains a certain portion of uncombined fire, and yet not any body which is not lighted or ſtrongly heated, excites in us any ſenſation of heat or light. Beſides, in certain circumſtances, a body may appear luminous, although it has no more ſenſible heat than the ſurrounding bodies. This is proved by the effects of ſeveral phoſphoric bodies, ſuch as the ſcales of fiſh, rotten wood, glow-worms; all which ſhine in the dark, although no more heated than the ſurrounding bodies. Alſo certain ſubſtances may be ſo penetrated with free and active fire, as to excite ſenſations of heat, and even to burn, although they do not appear luminous even in the dark. Amongſt theſe ſubſtances are ſtones, metals, and even water, all which may be ſo heated as to excite pain to perſons touching them, although they are not luminous.

Hence we ought to conclude, that the ſenſations of heat and light are in many caſes inſufficient to prove the preſence of any given quantity of fire in bodies.

We ought alſo to remark, that although all bodies penetrated with much fire are neceſſarily hot and luminous; heat, and not light, is the only certain ſign of the preſence of fire. The reaſon of this is, that bodies may be very luminous, without any change being induced into any of their eſſential qualities in theſe two contrary ſtates; whereas the difference of more or leſs heat produces in all bodies alterations of their properties very ſenſible and proportionable to the difference of heat.

Theſe conſiderations ſeem to have induced ſome philoſophers to imagine, that light is a being which is indeed rendered ſenſible by fire, but diſtinct and different from it. According to this opinion, heat is only a property of fire; whereas light is a diſtinct and independant ſubſtance. This opinion appears to be even demonſtrated, when we conſider that light may be decompoſed by refraction, as Newton's experiments ſhew; and that it is not, as pure fire is, capable of pervading all bodies, is proved by the opacity of many bodies, and by the reflexion of light.

However that may be, as heat occaſions more or leſs ſenſible changes in the qualities of all bodies; and as its whole action by which it influences any body conſiſts in the ſingle quality, or, to ſpeak more accurately, the eſſential fluidity of fire, of which heat is only an effect; we ought here only to conſider the general effects produced by fire upon all bodies by heating them more or leſs.

Theſe effects, although diverſified, depend nevertheleſs on one principle and primary change produced upon all bodies, by which they are rarefied or made to occupy a larger ſpace. In fact, every ſolid and fluid body, when penetrated by a greater or leſs quantity of diſengaged fire, is more or leſs encreaſed or diminiſhed in ſize than it was before.

This principle has ſuggeſted to philoſophers ſeveral different inſtruments by which this dilatation of heated bodies, or rather the heat which is the cauſe of it, may be meaſured; and quantities of fire, too ſmall to be eſtimated by our ſenſes, may be appreciated. The chief of theſe inſtruments is the THERMOMETER; *which ſee.*

As bodies are dilated by fire, their ſpecific gravity muſt conſequently be diminiſhed, and the adheſion of their integrant parts muſt alſo be diminiſhed. *See* AGGREGATION, INTEGRANT PARTS, *and* GRAVITY.

Theſe two great effects, produced by fire upon all bodies, are the moſt important and moſt neceſſary to be conſidered, relatively to chemiſtry. We may indeed ſay, that they are the only effects; for excepting combuſtion, which is a peculiar property of inflammable bodies, every chemical operation is performed either by a diminution of ſpecific gravity, or by a greater or leſs disjunction of the integrant parts of bodies, as we ſhall ſee.

Some ſubſtances are capable of a greater dilatation or diminution of their ſpecific gravity, than others, by fire. Thus certain matters are ſo much rarefied by even a moderate heat, that they ſeem to loſe all their ſpecific gravity, or become at leaſt ſpecifically lighter than all the ſurrounding bodies: hence theſe ſubſtances, when heated to a certain degree, are raiſed as bodies would be without gravity. All ſubſtances which have this property are called in general *volatile ſubſtances. See* VOLATILITY. Other bodies are ſo little dilatable by fire, relatively to their denſity, that the greateſt heat that can be given to them produces an almoſt inſenſible diminution of ſpecific gravity. Theſe are called, from their being almoſt unalterable in this reſpect by fire, *fixed bodies. See* FIXITY.

Hence, if we expoſe to fire a compound body containing ſome fixed and ſome volatile principles, the latter becoming ſpecifically lighter ought to riſe in vapors, and to ſeparate themſelves from the former, which are unalterable in this reſpect. But as almoſt all compounds contain principles differing ſo much in volatility and fixity, that ſome of them may be raiſed and ſublimed, while others ſhall remain fixed with ſome given degree of heat; we may therefore, by heat alone, make many analyſes and decompoſitions. If, for example, we expoſe a compound of regulus of antimony, which is a volatile ſemi-metal, and of gold, which is a fixed metal, to a heat ſo ſtrong that the volatility of the regulus of antimony ſhall take place; then this ſemi-metal, being raiſed by its acquired levity, will be ſublimed in vapors, and will be ſeparated from the gold, which will remain fixed and pure. *See* DISTILLATION, SUBLIMATION, EVAPORATION.

The obſervation we have juſt made concerning the changes in the ſpecific gravity of bodies, which the dilatation occaſioned by heat produces, ought alſo to be applied to the diminution of the adheſion of their integrant parts, which is an effect of the ſame cauſe; for if a body be dilated by heat, the contiguity, and conſequently the adheſion, of its integrant parts muſt be diminiſhed: but in this reſpect the ſeveral natural ſubſtances differ very much; for the integrant parts of ſome bodies, when dilated by heat, are ſo ſeparated and disjoined, that they ſeem no longer to cohere. If theſe bodies be naturally ſolid, they become fluid when they are penetrated with a ſufficient quantity of diſengaged fire, and are called *fuſible bodies*. Thoſe bodies, the integrant parts of which cannot be entirely diſjoined by fire, are called infuſible or refractory: but as the aggregation of a body is broken when it is fuſed, and as this deſtruction of aggregation is a neceſſary condition for the combination of bodies with each other; fire therefore, by rendering ſolid bodies liquid, has influence as a principal agent in all combinations. *See* COMBINATIONS, SOLUTIONS, FUSIBILITY, *and* REFRACTORY.

As all chemical operations may be reduced to decompoſitions and combinations, fire is therefore in chemiſtry, as in nature, an univerſal agent. Thus we know that, although decompoſitions and analyſes may be made by menſtruums without any more than the natural heat, yet as theſe menſtruums can only act when rendered ſufficiently fluid by heat, fire therefore acts in theſe analyſes as neceſſarily as in thoſe which are occaſioned by the immediate application of heat.

We ought to obſerve concerning this ſubject of the volatility, fixity, fuſibility and infuſibility of bodies, firſt, that all theſe qualities are properly only relative. Not any body is entirely fixed and infuſible; and thoſe which we conſider as ſuch would be reduced into vapors, as volatile bodies are, if they were expoſed to a heat infinitely ſtronger than any we can excite. Thus a body will appear fixed, or infuſible, when compared with other very volatile and very fuſible ſubſtances; while it ſhall be conſidered as volatile or fuſible, when compared with others more fixed and leſs fuſible.

In the ſecond place, as volatility and fuſibility are effects of one and the ſame cauſe, namely, of the dilatation occaſioned by the preſence of a certain quantity of uncombined fire in bodies, theſe two qualities are properly the ſame, in more or leſs eminent degrees; and in this ſenſe, volatility ought only to be conſidered as the higheſt degree of fuſibility. Accordingly, ſubſtances which are habitually liquid, and which ought therefore to be conſidered as the moſt fuſible, are all very volatile, and may be raiſed into vapors with very little heat; while, on the contrary, matters that are hard, and not very dilatable; thoſe, in ſhort, the aggregation of whoſe parts is the firmeſt and moſt difficultly to be broken, and which are therefore the leaſt fuſible, are alſo the moſt fixed.

The aggregation of all bodies, when reduced into vapors or fuſed, is broken; but more ſo when reduced into vapors, than when merely fuſed. Accordingly, the moſt effectual of all methods for combining ſubſtances which cannot be eaſily united, or which cannot be joined while the aggregation of one of them is ſenſibly preſerved, is, if poſſible, to reduce them into vapors, and to make theſe vapors meet.

All the effects which fire produces, as an agent in chemical operations, are reducible, as we ſee, to thoſe we have mentioned. The quantity of uncombined fire which flows perpetually from the ſun, and diffuſes itſelf through all its ſphere, is ſufficient to produce all the ſeparations and combinations which we daily ſee effected by nature: but as the heat cauſed by the ſun is very limited, chemiſtry would be confined almoſt to the contemplation of natural operations, if we had not methods by which pure and uncombined fire may be made to enter bodies, or to quit them in greater or leſs quantities.

The methods of encreaſing the quantity or the activity of uncombined fire in bodies, may be comprehended in the following three:

Firſt, by concave mirrors and by convex glaſſes, a number of the rays of the ſun, proportionate to the ſize and good quality of the inſtruments, may be collected into one point, called the *focus*. Bodies expoſed to ſuch a focus are penetrated with an infinitely greater quantity of uncombined and active fire than they have naturally. They are then ignited, inflamed, dilated, fuſed, or volatiliſed, according to their particular natures. The heat of ſuch a focus is the greateſt that art has produced. It is even exceedingly too ſtrong for moſt chemical operations, and ought to be applied to the moſt fixed and refractory bodies only. As ſuch a focus is alſo very ſmall and inconvenient for the performance of any operation, and as large mirrors and lenſes are very rare and dear, this fire is not much uſed for chemical operations. Neverthelefs, ſeveral very important chemical experiments were performed by collected ſolar heat; as the decompoſition of gold, publiſhed by Homberg, if it be true; the fuſion of platina, by Meſſrs. Macquer and Beaumé; and of ſeveral other bodies which could not be fuſed by other fires, without addition of other ſubſtances, by other chemiſts, at different times.

Secondly, experience has long ago taught us, and even the moſt ignorant nations know, that heat and all the effects of fire may be occaſioned by friction and percuſſion of hard bodies. The heat excited by this method may be very conſiderable, and even comparable to that of collected ſolar fire. It is in general proportionable to the force, rapidity, intenſity of friction and of percuſſion, and to the hardneſs of the bodies rubbed or ſtruck. This heat is alſo not much uſed in chemical operations: it, however, frequently occurs in many chemical experiments, as in fermentations, efferveſcences, and ſolutions. It occurs whenever bodies unite together; and is proportionable to the rapidity and force with which they act upon each other. It is produced by the friction and colliſion of their integrant parts; which ſhews, that the primary integrant parts are exceedingly hard, even in bodies generally ſoft or fluid; for theſe ſubſtances, when diſſolving, produce as much heat as thoſe which are moſt hard, and whoſe aggregation is moſt firm.

The third cauſe which produces or excites heat is the combuſtion of compound bodies, in the combination of which fire enters as an element or principle, and which are therefore called inflammable or combuſtible bodies.

The principal phenomenon preſented by theſe bodies is, that by mere contact with any other body, inflammable or not, but which is ignited, they are kindled, inflamed, give much heat and light; in a word, produce all the ſame effects as the collected ſolar heat, or the alliſions of hard bodies. This continues till the whole ſubſtance of fire, which entered into their compoſition, and which was inactive, has reſumed all the activity of pure and uncombined fire, and is entirely diſſipated.

This inflammation of combuſtible bodies is undoubtedly one of the greateſt and moſt aſtoniſhing phenomena of nature: but it is alſo one of the moſt difficult to be conceived. We cannot expect to underſtand it well, till we know, better than we do at preſent, the eſſence and true ſtate of fire when combined, and conſtituting a principle of the bodies containing it, called *phlogiſton.* *See* PHLOGISTON.

We muſt obſerve at preſent, that as the combuſtion of inflammable bodies produces all the effects of fire, pure, uncombined, and active; it is alſo the moſt convenient method by which fire can be applied by chemiſts to ſeveral bodies.

The moſt common inflammable ſubſtances, ſuch as wood, foſſil coal, charcoal, are moſt generally employed in chemiſtry, in the arts, and in the ordinary purpoſes of life, in all operations where fire is requiſite.

As chemiſts have occaſion to employ all the ſeveral degrees of heat, from the weakeſt to the ſtrongeſt, they have diſcovered methods of applying any required degree through intermediate ſubſtances, and ſtill better by the diſpoſition and conſtruction of furnaces, in which the combuſtible matters, and thoſe to which the fire is intended to be applied, are contained. *See upon this ſubject* BATHS, COMBUSTION, FURNACES.

FISH. *(c)*

FIXITY. Fixity is a property, by which a body reſiſts the action of fire, without being raiſed and diſſipated in vapors. It is the oppoſite quality to volatility.

The degree of reſiſtance which a body ought to give to fire, to entitle it to the character of being fixed, is not determined. Thus ſubſtances are conſidered to be fixed almoſt always relatively to others which are leſs fixed.

(c) FISH. Neuman obtained from ſixteen ounces of fiſh analyſed by diſtillation, thirteen ounces two drams and a half of volatile alkaline ſpirit, five drams of concrete ſalt, three drams of oil, and an ounce four drams and a half of reſiduum, from which, by calcination and elixation, twenty-five grains of ſaline matter were extracted. The proportion of volatile ſalt thus obtained from fiſh is conſiderably greater than that from fleſh.

As we do not know the ultimate degrees of the activity of fire, we cannot ſay whether any bodies in nature be capable of reſiſting this extreme degree of fire without ſublimation, or be abſolutely fixed.

Thoſe ſubſtances, however, are generally conſidered by chemiſts as abſolutely fixed, which loſe nothing of their quantity by expoſure to the moſt intenſe heat which they can produce. The pureſt and ſimpleſt earthy principle is a ſubſtance of this kind, and is perhaps the only one which can be conſidered as naturally fixed, and is the principle of fixity of all the reſt.

Chemiſts commonly call many ſubſtances fixed, which do not deſerve that name, but comparatively with others, as we have already mentioned. In this ſenſe, for inſtance, vitriolic acid is ſometimes called a fixed acid, by which is only meant that it is leſs volatile than others. For the ſame reaſon, regulus of antimony, and other ſemi-metals, may be conſidered as fixed ſubſtances when compared with eſſential oils and ether, particularly in operations where they remain fixed, when expoſed to a heat ſufficient to evaporate eſſential oils or ether; whereas theſe ſemi-metals may be conſidered as volatile, when compared with metals properly ſo called.

The fixity of bodies ſeems certainly to proceed from their little dilatability by fire; and this defect of dilatability is occaſioned by the attraction or adheſion of the integrant parts of theſe bodies. *See* FIRE *and* VOLATILITY.

FLAME. Flame is a collection of vapors of combuſtible bodies actually burning, and which are themſelves in the motion of combuſtion. *(d)*

As

(*d*) FLAME is generally ſaid to be an ignited vapor, or red-hot ſmoke. Neverthelefs, *Flame*, *Vapor*, and *Smoke*, are things diſtinct from each other, and ought not to be confounded together. We ſhall endeavour to deſcribe and diſtinguiſh theſe: and firſt, of *Vapor*.

By the action of certain determinate degrees of heat, with or without acceſs of air, all liquid and ſome concrete bodies are ſo dilated, as to occupy a much larger ſpace than before this expoſure to theſe determinate degrees of heat; acquire a conſiderable expanſive power, or elaſticity; and become tranſparent and inviſible. They are then properly vapors. This ſtate they retain while expoſed to the ſame heat by which it was produced; but by application of cold, they are condenſible into palpable ſubſtances, ſimilar to thoſe from which they were formed, if they happened

FLAME

As bodies cannot burn but by touching immediately the air, and as for this reaſon they only burn at their ſurface, flame, which is the only truly burning part of bodies which appear in actual combuſtion, is always at their ſurface. It is luminous and ardent throughout its whole thickneſs, becauſe it is only a maſs of adjacent, but diſunited inflammable

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pened to conſiſt of homogeneal parts, as water and mercury do; or they are condenſible into palpable ſubſtances which are the conſtituent parts of the bodies ſubjected to heat, if theſe bodies happened to conſiſt of parts not homogeneal, as plants do of water and eſſential oil. If the vapor conſiſts of inflammable parts, it may be kindled by contact with any ignited body; by which means, together with acceſs of air or nitrous acid, it may be made to undergo thoſe effects which are produced upon all bodies during their combuſtion, namely, the decompoſition of its parts, the diſſipation of its phlogiſton, and emiſſion of heat and light: but vapor thus ignited, rendered viſible, and in the act of combuſtion, by acceſs of air, or nitrous acid, is *flame*. This flame, or vapor decompoſing by combuſtion, is not condenſible, as we may eaſily conceive, into ſuch palpable ſubſtances as the undecompoſed vapor is; but into ſome only of the conſtituent parts of theſe ſubſtances, the reſt being altered by the combuſtion. Thus the vapor of ſpirit of wine is again condenſible into ſpirit of wine; but from the flame of ſpirit of wine little can be obtained by condenſation but the water, which was one of the conſtituent parts of that ſpirit; the other parts, eſpecially the phlogiſton, being deſtroyed by the combuſtion, that is, combined with the air which aſſiſted the inflammation.

Not only the vapor of an inflammable body, but alſo the inflammable body itſelf, without being previouſly changed into vapor, may by contact with an ignited body, or any other mode of application of heat, as friction, percuſſion, &c. together with acceſs of air or nitrous acid, emit a flame, which conſiſts, as in the former caſe, of particles flying off from that body in the act of combuſtion. Thus, by applying a hot iron to ſulphur, we may ſee a flame immediately produced upon the ſurface of the ſulphur. We may eaſily conceive that bodies thus kindled can only flame at their ſurfaces, becauſe there only they are contiguous to air: but when nitre is intimately mixed with the inflammable ſubſtance, as in gun-powder, the whole ſubſtance, its interior as well as its exterior parts are inſtantly inflamed; becauſe the nitrous acid has, like air, the property of maintaining combuſtion. Hence alſo we may eaſily conceive why the external ſurface of a flame, by being contiguous with air, is much hotter than its internal parts, as may eaſily be ſhewn by applying any ſubſtance, alterable by heat, alternately to the exterior and interior parts of the flame of a candle; and when mable parts, which, touching the air on every ſide, burn altogether and throughout their whole ſubſtance.

No combuſtible body really burns without flame. Thoſe, indeed, whoſe inflammable principle is firmly united with a great quantity of incombuſtible matter, ſuch as charcoal or aſhes almoſt entirely burnt, and moſt metals, ſeem to be conſumed without ſenſible flame; but this appearance does not impoſe upon an accurate obſerver. The appearance of a body which really burns is very different from

when a vapor of a conſiderable diameter, as of a foot or eighteen inches, is kindled, and the combuſtion is maintained only by the air contiguous to it, as when the vapor iſſuing at the upper mouth of a furnace for ſmelting iron ore is kindled by contact of any ignited body, the flame will then be found to have a thickneſs only of an inch or two, while the vapor near the center, ſurrounded by this flame, is not inflamed, as appears from paper or other eaſily combuſtible matter being held in it without being kindled.

Smoke conſiſts of palpable particles, elevated by means of the rarefying heat, or by the force of the aſcending current of air, from bodies expoſed to heat. Theſe particles vary much in their properties according to the ſubſtances from which they were produced. Vapors alſo riſing from heated bodies, when condenſed by the coldneſs of air or other contiguous bodies, become palpable, and therefore have the appearance, and may be conſidered as ſmoke. The ſmoke ariſing from combuſtible bodies conſiſts of parts, ſome of which are generally combuſtible, but ſo difficultly combuſtible, that a greater heat is required than they poſſeſs while they are ſmoke, to effect their combuſtion. The flame alſo of combuſtible bodies may be ſo cooled by the application of cold air, or other cold ſubſtances, as that the combuſtion of the particles compoſing it ſhall be checked, and theſe particles ſhall become ſmoke. Thus the flame of a candle is, by the coldneſs of the air, diminiſhed more and more as it riſes higher, till at laſt it is extinguiſhed, before all its inflammable parts are conſumed, and accordingly its point terminates in ſmoke.

The ſmoke of burning inflammable ſubſtances, when collected, is called *ſoot*. The ſmoke of uninflammable ſubſtances, or of inflammable ſubſtances not expoſed to air, and conſequently not burning, conſiſts of the ſubſtances not altered or decompoſed, but only divided, as the flowers of ſulphur raiſed by heat in cloſe veſſels, and the flowers of ſal ammoniac; or it conſiſts of parts of theſe ſubſtances decompoſed merely by heat, and not by combuſtion; as the flowers of ſulphur and of arſenic, from the mineral containing theſe called pyrites, expoſed to heat in cloſe veſſels; and the flowers of benzoin, ſublimed by heat from the reſin of that name.

that of a body which is only made red-hot, by being penetrated with a fire proceeding from ſome other ſubſtance, which does not itſelf burn. Let a bar of iron be compared with a flint, when both are taken out of a fire ſo intenſe as to give to each of them a white heat, and the ſurface of the metal will ſeem covered over with a ſmall flame, which is indeed very low, but bright and ſparkling; while nothing ſimilar will appear on the ſurface of the flint. Beſides, the flint will loſe its vivid color much ſooner than the iron. If we obſerve lead while it is ſcorified in a cupel under a muffle, we ſhall ſee in a ſtriking manner that the metal ſhall be much more ardent and luminous than the cupel, although theſe two bodies are expoſed preciſely to the ſame degree of heat; but this difference can certainly proceed only from the ſmall flame which neceſſarily accompanies the combuſtion of the metal; while the cupel which contains no combuſtible principle, and which conſequently cannot burn, does not exhibit any ſuch appearance.

All bodies, therefore, which do really burn, ſeem to burn with flame; but the flames proceeding from the different combuſtible bodies, differ very much from each other, according to the nature of theſe bodies, and to the particular ſtate of their phlogiſton. I do not know whether the flame of any combuſtible body be entirely pure. Such a flame would be nothing elſe than phlogiſton ſeparated from all other ſubſtances reduced into vapor, and actually ignited. The flames of rectified ſpirit of wine and of perfect coal ſeem to be the pureſt of all, becauſe they are accompanied with no ſmoke nor fuliginous matter. Nevertheleſs, the flame of ſpirit of wine is accompanied with much water. *See* SPIRIT *of* WINE. All other flames are evidently mixed with heterogeneous ſubſtances, which diſcover themſelves by different qualities.

The leaſt pure of all flames is that of oils and of all oily matters, becauſe it proceeds from very compound bodies. This flame is always mixed not only with all the volatile principles of the oil, or oily body, but alſo with a conſiderable quantity of the fixed principles which are raiſed by the deflagration. Beſides, although it is conſiderably luminous, all the phlogiſton which it contains is not burnt: a portion of it remains combined in the ſtate of coal with earth. Hence the flame of all oils is accompanied with a fuliginous ſmoke, which blackens bodies that it touches. As this property belongs to the flames of all oils and oily matters, and to none elſe, it is a mark by which we may diſcover whether the phlogiſton of any body be in an oily ſtate. *See* OIL, FULIGINOSITY, SMOKE, *and* SOOT.

The flame of metals is alſo accompanied with a ſenſible ſmoke, which is even very conſiderable and thick in certain metals. But this flame does not, like that of oils, blacken ſubſtances which it touches; becauſe metals are not in an oily ſtate. *See* METALS.

Laſtly, the flame of ſulphur would be very pure, if it was not for the vitriolic acid, a large quantity of which is mixed with it. Perhaps the flame of this compound would be very pure, if the ſulphur was previouſly mixt with fixed alkali to abſorb the acid, in Stahl's manner, and if it was made to burn ſo weakly as not to be capable of kindling combuſtible bodies. *See* SULPHUR.

FLINTS. *See* EARTHS (VITRIFIABLE). *(e)*

FLOWERS. By this name is generally underſtood bodies reduced into very fine parts, either ſpontaneouſly, or by ſome operation of art; but it is applied chiefly to volatile ſolid ſubſtances, reduced into very fine parts, or into a kind of meal by ſublimation.

Some flowers are nothing elſe than the bodies themſelves, which are ſublimed entire, without ſuffering any alteration or decompoſition: and other flowers are ſome of the con-

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(*e*) FLINTS are ſemi-tranſparent or opake ſtones, generally of a roundiſh form, and covered with a white cruſt, of a ſmooth, uniform, ſhining texture, ſo hard as to ſtrike fire with ſteel; calcinable by fire, ſo as to become white, brittle, and, according to Henckel, heavier than before calcination; not ſoluble by acids; and vitrifiable only by the very violent heat of the largeſt ſpeculums, ſuch as that of Vilette, and not even by the focus of a lens of Tſchirnhaus, according to an experiment of Neuman. They are found generally in beds of chalk and of ſand, but never forming entire ſtrata of rock, as jaſper does. By long expoſure to air and to the ſun, they ſeem to decay, to loſe their luſtre, their firmneſs of texture, and to be changed to a white calcareous earth or chalk. Hence they are almoſt always found covered with a white chalky cruſt. They are alſo convertible into calcareous earth by fuſion, or vitrification with ſo much fixed alkali, that they ſhall reſolve into a liquid maſs called the liquamen of flints, and by precipitation from the fixed alkali by means of acids. *See* LIQUOR *of* FLINTS.

Flints are of the claſs of earths called *vitrifiable,* becauſe theſe earths are generally employed, together with fixed alkali, as materials in the making of glaſs. *See* GLASS, *and* EARTHS (VITRIFIABLE).

ſtituent parts of the body ſubjected to ſublimation, as we ſhall ſee in the following articles, when we define the principal matters diſtinguiſhed by the name of flowers.

FLOWERS *of* ANTIMONY. Antimony, which is a mineral compoſed of the ſemi-metal called regulus of antimony and ſulphur, is entirely volatile, and capable of being ſublimed into flowers.

To make flowers of antimony, an earthen pot or large crucible, in the upper and lateral part of which is an opening, is placed in a furnace, and three or four aludels are fitted to it. The pot is to be made red-hot, and powdered antimony is to be thrown into it through the lateral opening, and the ſublimation is then to be made. Theſe projections of antimony are to be repeated till the operator judges that the inner ſurface of the aludels is ſufficiently covered with flowers, which are to be detached from thence with a feather.

The veſſels employed for this ſublimation muſt not be exactly cloſed, for two reaſons; firſt, that acceſs of air favours and accelerates all ſublimations, and particularly this. Lemery obſerves juſtly, that the operation is accelerated greatly by directing a blaſt of wind upon the ſurface of the antimony. In the ſecond place, if the veſſels were perfectly cloſed, they would burſt by the expanſion of the vapors, or of the contained air.

Although all flowers of antimony be compoſed of regulus of antimony and of ſulphur, as the antimony itſelf is, they neverthleſs differ from it eſſentially in many reſpects. They have not the ſame metallic brilliancy. Their color is different ſhades of white, grey, and yellow. They are powerfully emetic. Theſe differences prove, that antimony ſuſtains a conſiderable alteration by this ſublimation. This alteration conſiſts in the diminiſhing the connexion betwixt the ſulphur and the regulus of antimony.

The difference of colors in flowers of antimony proceeds from the variable action of the fire and of the air upon this mineral during the operation. Probably the emetic quality of flowers of different colors alſo differs. But this difference has not been obſerved, as the flowers of antimony have not been much employed, becauſe of their uncertainty.

RED FLOWERS *of* ANTIMONY. Lemery gives a proceſs for making the red flowers of antimony. It conſiſts in diſtilling eight ounces of antimony, mixed with fourteen ounces of ſal ammoniac, or of flowers of ſal ammoniac.

moniac. Some volatile alkali is raiſed from the ſal ammoniac, and red flowers are ſublimed.

The portion of volatile alkali which riſes in this operation is diſengaged by the reguline part of antimony; and as one part of this volatile alkali acts at once upon the ſulphur and upon the regulus of antimony, an antimoniated volatile liver of ſulphur is formed. Theſe red flowers are a kind of kermes, and differ from the ordinary kermes in having a volatile inſtead of a fixed alkali. They are emetic, purgative, diaphoretic, inciſive, &c. as kermes is, and may be given in the ſame doſe as kermes is; but are ſeldom uſed. However, a kermes made with volatile alkali may have peculiar virtues, and deſerves the attention of phyſicians; but in this caſe it ought to be prepared in a more certain manner, by employing uncombined volatile alkali.

FLOWERS (ARGENTINE) *of* REGULUS *of* ANTIMONY. To make theſe flowers, regulus of antimony is put into an unvarniſhed earthen pot, which is to be placed in a furnace ſo that its bottom may be red-hot, while its upper part ſhall be much colder. The pot is to be covered with a lid, without luting it, and heat is to be applied during an hour or more. When the pot is cold, its internal ſurface, and alſo the remaining part of the regulus, is found covered with white flowers, in form of beautiful, tranſparent, and ſhining needles. Theſe flowers are to be gathered with a feather. After this, a ſecond ſublimation may be commenced, and managed as the former was; and thus the whole regulus may be changed into flowers, which requires much time.

Lemery directs that a ſmall lid or diaphragm ſhall be placed within the pot, at the height of three or four fingers thickneſs above the regulus. But this appears to be unneceſſary. Mr. Beaumé does not uſe this ſecond lid. He only inclines the pot ſo, that all the upper part of it ſhall be out of the furnace. He makes the bottom of it very hot; and thus obtains a large quantity of flowers.

Theſe flowers appear to be nothing elſe than the earth of regulus of antimony deprived of almoſt all its phlogiſton. They are not emetic nor purgative. They are not very volatile, and cannot eaſily be reduced into regulus. They are ſoluble in aqua regia. All theſe properties, together with their remaining degree of volatility, ſhew that they contain ſome inflammable principle. They have alſo conſiderable marks of a ſaline ſubſtance. They have not only the appearance of a cryſtallized ſalt, but are alſo entirely ſoluble in water, as Mr. Beaumé obſerves; although a large quantity of water, which muſt alſo be boiling, is required for that purpoſe. Eight ounces of boiling water are capable of diſſolving half a grain of theſe flowers. From this property we may ſuſpect that regulus of antimony contains a ſaline matter as one of its conſtituent parts, which is conformable to the opinion of ſome chemiſts concerning ſalts and metals.

Nevertheleſs, if we conſider that regulus of antimony cannot be deprived of all the ſulphur with which it is united in its mineral ſtate, we may ſuppoſe that part of the acid of ſulphur may, by uniting with the earth of the regulus of antimony, give the ſaline qualities to the flowers of this metallic ſubſtance.

FLOWERS *of* ARSENIC. The white flowers of arſenic are nothing but white arſenic itſelf; which being a volatile ſubſtance, unalterable by ſublimation, may be raiſed altogether, without any change.

Flowers of arſenic are made, as all other flowers are, by ſubliming arſenic. *See* SUBLIMATION.

We ought to obſerve that they are not perfectly white, unleſs the arſenic from which they have been ſublimed has been perfectly dephlogiſticated and white. If the arſenic which is ſublimed be mixed with a little ſulphur, the flowers will be more or leſs yellow, or red, according to the quantity of ſulphur which is ſublimed along with them. If the arſenic be in a reguline ſtate, or conſiderably phlogiſticated, its flowers will be more or leſs greyiſh or brown. Hence we ſee veins of theſe different colors among the arſenic which is found in commerce, and which is obtained by ſublimation in great works from arſenical minerals.

As arſenic is very fuſible, when theſe flowers fix themſelves to any ſubſtance conſiderably heated, they ſuffer a kind of fuſion, are agglutinated together, and form the denſe, compact, heavy, ſhining maſſes which are in the ſhops of druggiſts. The nature and properties of flowers of arſenic do not differ from thoſe of arſenic. *See* ARSENIC.

FLOWERS *of* BENJAMIN, *or* BENZOIN. To make flowers of benjamin, let a quantity of benjamin be put into a varniſhed earthen pan, which is to be covered with another inverted pan of ſtone ware. The edges of theſe two pans ought to have been ground upon a ſtone, ſo that they fit well to each other. They are to be luted together with paper dipped in paſte. The earthen pan containing the benjamin is to be put upon a gentle fire, and which is not capable of raiſing the oil of the benjamin. With that heat the ſublimation is to be performed: when the veſſels are cooled, they are to be unluted, and great care is to be taken that they be not ſhook. If the ſublimation has been performed, the inner ſurface of the upper earthen pan will be found covered with fine ſparkling flowers like a very pure ſalt, forming cryſtals like flattened needles. A conſiderable quantity alſo of theſe flowers is generally found which are not raiſed, and which cover the ſurface of the remaining benjamin. The flowers are to be ſwept off with a feather.

The ſucceſs of this operation depends on the degree of heat given, and the time employed. If the heat be too great, a part of the oil of benjamin will riſe together with the flowers, which will thence receive a dirty yellow tinge. In this caſe they muſt be again ſublimed, and with a leſs heat. If, on the contrary, a ſufficient degree of heat is not given, or the operation has not been long enough continued, all the flowers which the benjamin is capable of furniſhing will not be procured. The ſame benjamin will, by repeating the operation, furniſh more flowers.

The proceſs formerly uſed to make theſe flowers conſiſts in putting the benjamin in an earthen pot, to the mouth of which is fitted a paper, or paſteboard conical head. But the method deſcribed above, which is propoſed by Mr. Beaumé, ſeems to be preferable: becauſe the paper or paſteboard heads abſorb many flowers, which are conſequently loſt, and alſo becauſe the earthen veſſel employed by Mr. Beaumé has a greater ſurface than the pot uſed in the ancient method; and quantity of ſurface is always favourable to ſublimation.

The flowers of benjamin are a true concrete, volatile, and oily eſſential ſalt of benjamin. They have the ſmell of benjamin, and are inflammable, from the eſſential oil which enters their compoſition. They are ſoluble in water and in ſpirit of wine, which ſufficiently proves their ſaline nature. Accordingly, Mr. Geoffroy obſerves, that this ſalt may be obtained by treating benjamin with water, and by cryſtallization.

Benjamin is probably not the only reſin from which an eſſential ſalt of this kind may be obtained: perhaps, even all reſins contain ſuch eſſential ſalt, in greater or leſs quantity; and this is certainly one of thoſe which contain a great quantity of it.

Flowers of benjamin are conſidered in medicine as inciſive, dividing, and favoring expectoration, and are therefore given in the viſcous aſthma. They may be given from ſix grains to twelve. *See* RESINS, *and* SUBLIMATION.

FLOWERS *of* SAL AMMONIAC. The flowers of ſal ammoniac are nothing elſe than ſal ammoniac ſublimed; for this ſemi-volatile ſalt ſuffers no decompoſition by ſublimation. The proceſs for making theſe flowers contains nothing ſingular, excepting that an equal part of decrepitated common ſalt is generally mixed with the ſal ammoniac, in order to divide this latter ſalt, and to facilitate its ſublimation. By this ſublimation, ſal ammoniac may be purified from fuliginous and other matters, with which it is generally mixed. But it may be better and more conveniently purified by ſolution in water, by filtration, and by cryſtallization. For this ſalt has the property of raiſing along with it in ſublimation very fixed matters, as we ſee from the example of the flowers of ſal ammoniac tinged with copper and with iron, called *ens martis*, and *ens veneris*, which are nothing elſe than ſal ammoniac ſublimed with iron and with copper. *See* AMMONIAC (SALT).

FLOWERS *of* SULPHUR. Flowers of ſulphur are crude ſulphur ſublimed in an apparatus of aludels. Sulphur cannot be decompoſed without an intermediate ſubſtance in cloſe veſſels. Therefore flowers of ſulphur have no properties different from thoſe of pure ſulphur in maſſes. *See* SULPHUR.

FLOWERS *of* ZINC. Flowers of zinc are the metallic earth of zinc, deprived of almoſt all its phlogiſton, and raiſed in light flocks from deflagrating zinc.

To make theſe flowers, zinc is to be put into a large open crucible, ſet in a furnace which draws air well. When a white heat is raiſed, the zinc kindles and burns with a white, vivid, dazzling flame, accompanied with a conſiderable quantity of white ſmoke. This ſmoke is condenſed in white light flocks, which float all round the laboratory. The greateſt part of theſe flocks, however, fix themſelves to the ſides of the crucible and to the zinc. They are called *flowers of zinc*, *nihil album*, or *pompholix*.

Although theſe flowers are raiſed into ſmoke in this operation, like a very volatile ſubſtance, they are really very fixed, as metallic earths are, when well dephlogiſticated; and are ſo incapable of being again ſublimed, that they reſiſt the moſt violent fire, and are ſooner melted than ſublimed. If they are then raiſed in ſmoke during deflagration, this effect is produced by the activity with which the zinc burns; and for the ſame reaſon, earths and coals extremely fixed are found in ſoot of wood and of moſt other combuſtible matters.

The flowers of zinc are ſoluble in acids, nearly as zinc is. *See* ZINC. The cauſe of this may be, that they retain ſome phlogiſton. But they are difficultly reducible into zinc, and were even believed to be incapable of reduction, till Mr. Margraaf publiſhed a method of reviving them, by expoſing them to a ſtrong heat together with ſome inflammable ſubſtance in cloſe veſſels.

In the crucible uſed for the preparation of flowers of zinc, a conſiderable quantity of theſe flowers is found fixed to its ſides, and to the ſurface of the zinc, if any remains unburnt. Theſe latter flowers are much leſs white and light than the former. They have been produced by the part of the zinc which burnt leſs vehemently than the reſt. Their color is greyiſh, from a certain quantity of phlogiſton which they retain.

Flowers of zinc alſo are obtained from furnaces in which minerals containing zinc are ſmelted, particularly that of Rammelſberg. They adhere in great quantities to the upper part of the internal ſurface of the walls of the furnaces. But as theſe flowers ſuſtain a great heat, they are half fuſed and agglutinated together, forming maſſes, which muſt be taken off frequently in order to clear the furnaces. Flowers of zinc in this ſtate are called *cadmia fornacum*, or *pompholix*. *See* CADMIA *and* ZINC.

FLOWERS *of* VEGETABLES. (f)

FLUIDITY.

(f) FLOWERS. In this article, which is extracted from Dr. Lewis's notes on Neuman's Chemiſtry, the *colors* only of flowers ſhall be conſidered. Very few of the colors of flowers of vegetables are durable, or can be made durable by any means known. The only permanent color is *yellow*. The *red*, the *blue*, the *purple*, the *crimſon*, and the *violet*, are very periſhable. Many flowers loſe theſe colors merely by being dried, eſpecially by being ſlowly dried in a ſhady and not warm place. The colors of all of them periſh by keeping, even in the cloſeſt veſſels. The more haſtily they are dried, and the more perfectly they are ſecured from air, the longer they retain their beauty. The coloring matter of flowers extracted and applied on other bodies is ſtill more periſhable.

FLUIDITY. Fluidity is the ſtate of a body whoſe integrant parts are ſo diſunited and incoherent, that no ſenſible reſiſtance is oppoſed to their ſeparation in any direction; but which are nevertheleſs ſufficiently attracted by each other, to remain adjacent, and to form an aggregate body.

Hence fluidity is a middle ſtate betwixt hardneſs, in which the integrant parts of bodies adhere together firmly, and the entire want of aggregation, in which the integrant

parts

Blue Flowers. The color of many blue flowers is extracted by infuſion in water; but from others, water acquires only a purpliſh hue. Of thoſe which have been tried, not one gives a blue color to ſpirit of wine: ſome give no color, and ſome give a reddiſh color. The expreſſed juice of theſe flowers is generally blue. The blue juices and infuſions are rendered red by all acids: and the moſt florid red is given to them by marine acid. The flowers alſo, by maceration, impart a red color to acid liquors. Alkalis fixed and volatile, and lime water, change theſe blue colors to green. And thoſe infuſions or juices which have nothing of the color of the flower, ſuffer the ſame changes from the addition of acid and alkaline liquors. Even when the flowers have been kept till their colors are loſt, their infuſions acquire a red color from acids, and a green color from alkalis, but in a leſs degree than when the flowers were freſh. The red color produced by acids is ſcarcely more durable than the original blue: applied upon other bodies, and expoſed to air, it gradually degenerates into a faint purple, and at laſt diſappears, without leaving a ſtain behind. The green produced by alkalis changes to a yellow, which does not fade ſo ſoon. The green made by lime-water is more permanent and beautiful. Green lakes, prepared from blue flowers by means of lime-water, have been uſed by painters. The flowers of *cyanus* have been much commended for affording elegant and blue pigments. But Dr. Lewis has not been able to extract from them any blue color. They retain their color, when haſtily dried, longer than other blue flowers, but do not communicate their original color to any menſtruum.

Red Flowers readily communicate their color to water; and thoſe of a full red color give to a rectified ſpirit alſo a deep red tincture, brighter, though ſomewhat paler, than the watery infuſion. But the lighter red flowers, and thoſe which are purpliſh, impart little color to pure ſpirit. The colors of infuſions of theſe flowers are ſuppoſed to be heightened by acids, and to be rendered green by alkalis. But this is not univerſal. For amongſt thoſe examined by Dr. Lewis, the roſe colors and purpliſh red were changed by acids nearly as blue flowers are; but the full

deep

parts of bodies are ſo ſeparated and removed from each other, that their mutual attraction is no longer ſenſible.

A body may be fluid in two manners; firſt, by the figure of its primitive integrant parts, ſo that each of theſe parts ſhall not touch any other but in one point, or in one infinitely ſmall ſide, and conſequently have but little or no adheſion. Such a body muſt neceſſarily and naturally be fluid. Fire ſeems to be the only body poſſeſſed of this eſſential fluidity.

The ſecond manner by which a body may be rendered fluid is, to leſſen the contact of the integrant parts, to disjoin them, or even to ſeparate them from each other by

deep reds were not. The deep infuſion of red poppies was turned by alkalis not to a green, but to a duſky purple.

Yellow Flowers communicate to water and to ſpirit of wine durable yellow colors, not alterable but in degree by acids or by alkalis; the former only rendering them paler; and the latter, as alſo alum, rendering them deeper. Wool, or ſilk, impregnated with a ſolution of alum and of tartar, receives, on being boiled with the watery infuſion or decoction, a durable yellow dye. A durable yellow lake is prepared by precipitating with alum an infuſion of yellow flowers made in an alkaline ley. In ſome of the *orange-colored flowers* the yellow matter ſeems to be of the ſame kind as that of the pure yellow flowers; but the red matter ſeems to be different from that of the pure red flowers. The yellow matter is extracted from theſe flowers by water; and the remaining red matter is extracted by ſpirit of wine, or by a weak ſolution of fixed alkali in water. Such are the ſaffron-colored flowers of *Carthamus*. Theſe flowers, after the yellow matter has been extracted by water, are ſaid to give a red tincture to ley, from which a deep red fecula ſubſides, called *Safflower*, *Spaniſh red*, and *China-lake*. This pigment gives a beautiful red color to ſpirit of wine, but none to water. The yellow farina or fine duſt, reſting on the tips of the ſtamina of flowers, gives a fine bright yellow color to ſpirit of wine, and a duller yellow color to water. The colors of both the watery and ſpirituous tinctures were heightened by alkalis, rendered red by acids, and again reſtored to a yellow by adding an alkali. This is the only known inſtance of the yellow color of a vegetable being rendered red by acids.

White Flowers, or their expreſſed juices, impart a green color to alkaline leys, but have not been obſerved by Dr. Lewis to give a red color to acids. The white flowers of the common wild *convolvulus* give a deep yellow or orange color to water, which is affected by acids, by alkalis, and by alum, as the infuſions of yellow flowers are. The white flowers of *Xeranthemum* give a beautiful yellow color to water acidulated with ſpirit of nitre.

the interpoſition of a fluid. All bodies which can only be fluid in this manner, are evidently not eſſentially fluid. On the contrary, they are naturally more or leſs hard and ſolid, and can only have a mediate or ſecondary fluidity. Such all bodies in nature appear to be, excepting fire. Hence, without fire no fluid would exiſt; all bodies would cohere together, and form a ſingle, ſolid maſs; and hence fire is the principle of all fluidity. But when a body is rendered fluid by fire, it may then be capable of giving fluidity to other bodies. Water, for inſtance, the fluidity of which is certainly cauſed by fire, may, by interpoſing itſelf betwixt the integrant parts of gums and ſalts, give to them a fluidity ſimilar in ſome reſpects to its own.

We muſt not confound the fluidity received directly from fire with the fluidity received from bodies rendered fluid by fire. Some ſubſtances are incapable of receiving fluidity directly from fire, but only through the intervention of ſome other ſubſtance previouſly rendered fluid by fire. Such are gums, which are rather decompoſed than rendered fluid by fire, but which are readily ſoluble in water. Other bodies may be either rendered fluid directly by fire, or ſecondarily through the intervention of another body previouſly rendered fluid by fire. Such, for inſtance, are ſalts. They become fluid when expoſed alone to the action of fire, and are alſo capable of liquefaction by water.

The principal difference betwixt a body rendered fluid merely by the action of fire, and another body rendered fluid by the interpoſition of a fluid ſubſtance, is, that the integrant parts of the latter body adhere to thoſe of the interpoſed ſubſtance; and that this adheſion or affinity is the cauſe of the fluidity of that body.

This ſecondary fluidity, therefore, given by interpoſition of a fluid ſubſtance, is nothing elſe than a ſolution. The fluidity given immediately by fire is called by chemiſts, *fuſion*; we therefore ſay that a ſalt is diſſolved in water, but not fuſed or melted. This latter expreſſion is frequently uſed, though very improperly.

Theſe evident and important differences betwixt the fluidity of fire, which is eſſentially fluid, the fluidity of bodies fuſed merely by the action of fire, and the fluidity of bodies rendered fluid by the interpoſition of others already fuſed, require that theſe different kinds of fluidity ſhould be diſtinguiſhed by names appropriated to each. At preſent no ſuch preciſe expreſſions have been uſed to denote them. Bodies habitually fuſed might be called *fluid*, and thoſe which have only a ſecondary fluidity might be called *liquid.* But what name ſhall be given to the primary and eſſential fluidity of fire?

This want of ſuitable expreſſions ſhews the little attention given by chemiſts and natural philoſophers to fluidity, and to the properties of bodies by which they give and receive fluidity. From not having reflected on the properties of fire, and upon the effects which it produces upon other bodies, we have conſidered thoſe ſubſtances as having an independent fluidity, which we have generally ſeen in a fluid or fuſed ſtate; ſuch as air, ethereal ſpirits, mercury, ſpirit of wine, and even water and oils; although we frequently ſee theſe two laſt mentioned ſubſtances become ſolid by cold, or want of active fire. The fixation of mercury by a ſufficient degree of cold, the poſſibility of which is ſuſpected in the *Elements of the Theory of Chemiſtry*, and is aſcertained by experiments of ſome Members of the Academy at Peterſburgh, induces us to conjecture, that every body is naturally ſolid or hard; and that all fluid bodies receive their fluidity from fire, which is the only ſubſtance eſſentially fluid.

However that may be, this is evident, that as the aggregation of every body which is fluid or liquid muſt be broken, or much diminiſhed, fluidity is the moſt favourable ſtate for the formation of new unions; and that every ſubſtance which forms a new combination muſt neceſſarily have or acquire this ſtate. Therefore a preciſe and extenſive knowledge concerning fluidity, and the properties of bodies by which they give and receive fluidity, is exceedingly important in chemiſtry. *See* AGGREGATION, SOLUTION, FIRE, FUSION, *and* LIQUEFACTION.

FLUOR. This word, uſed as an adjective, is applied to ſignify the habitual fluidity of any ſubſtance, or that property by which a ſubſtance cannot be rendered ſolid, and is employed as an epithet to diſtinguiſh ſuch ſubſtances from others of the ſame kind, but which are habitually ſolid, or which may be rendered ſolid. Acids, for inſtance, which are habitually fluid, as all the mineral and ſome vegetable acids, are called *fluor acids*, in order to diſtinguiſh them from the acid of tartar and acid eſſential ſalts, which are naturally concrete. Alſo volatile alkali treated with quicklime, or with metallic earths, ſo that it is always liquid and not cryſtallized, is called *fluor volatile alkali*, to diſtinguiſh it from the concrete and cryſtallizable volatile alkali.

F L U O R

By *fluor*, uſed ſubſtantively, is meant a certain kind of ſtone which is fuſible, or which facilitates fuſion. Such are the greateſt part of *ſpars*, which are called fluors. Thus, for example, in talking of a white or colored ſpar, which is found in the matrix of an ore, we ſay that this matrix is mixed with a white, green, or yellow fluor. *See* SPAR. (g)

FLUX.

(g) FLUORS. Fluors are ſtones or ſpars of different colors, purple, green, yellow, &c. more or leſs tranſparent, which are commonly found in veins of ores, and ſerve as the matrix to the minerals which they invelop. Moſt of them affect a cubical form, but others are found in lumps which have no determinate ſhape. They may be diſtinguiſhed from other ſtones by the following properties.

1. They are not ſufficiently hard to ſtrike fire with ſteel. By this property they are diſtinguiſhed from the colored quartz cryſtals, called falſe emeralds, falſe rubies, &c. which names have alſo been improperly applied to the cubical colored fluors.

2. They are not ſoluble by acids, and thus are diſtinguiſhable from calcareous ſpars.

3. When calcined without addition, and mixed with water, they do not form plaſter; and when calcined with addition of inflammable matter, they cannot be formed into the Bolognian phoſphorus. Hence they may be diſtinguiſhed from the gypſeous phoſphoric ſpars and ſtones.

4. They are fuſible by fire without addition, according to M. Engeſtrom, and M. D'Arcet.

5. They greatly facilitate the fuſion of calcareous and argillaceous earths; and alſo of the topaz, according to Mr. Pott. They are much employed in the ſmelting of ores, as they promote the fuſion of the adhering earths.

6. When expoſed to fire till they become red-hot, they emit ſome lucid rays in the dark; but their light is very weak, and afterwards they crackle and break into ſmall pieces: whereas, the gypſeous phoſphoric ſpars expoſed to the ſame heat emit a vivid light, and then break aſunder into pieces not ſo pulverable as thoſe of the heated fluors.

M. Margraaf has made experiments, in order to diſcover the nature of theſe ſtones. He aſcertained the diſtinctions above mentioned between them and the gypſeous ſpars, and therefore infers that they are not compounded of vitriolic acid with calcareous earth. He obſerved ſingular appearances on mixing them with vitriolic and other acids, and ſubjecting the mixtures to diſtillation.

Eight ounces of the powder of a green fluor, being mixed with an equal weight of pure oil of vitriol, and diſtilled together with a graduated heat, yielded after the watery part of the acid had paſſed, a fine white ſublimate, which aroſe and adhered to

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FLUX. This word is ſometimes uſed ſynonimouſly with *fuſion.* For inſtance, an ore, or other matter, is ſaid to be in liquid flux, when it is completely fuſed.

the neck of the retort, and even paſſed into the receiver. The firſt parts of this ſublimate which aroſe, appeared like butter of antimony; and like this butter, they melted by the heat of a live coal, brought near the neck of the retort: But the parts which aroſe towards the end of the operation, with the greateſt degree of heat, could not be melted by that heat. The retort being broken, a reſiduum was found weighing 12 oz. Hence 4 oz. of oil of vitriol remained united with the ſpar. The bottom of the retort was obſerved to be pierced with holes. Laſtly, the liquor, which had paſſed into the receiver, and the white ſublimate, had very ſenſibly a ſulphureous ſmell. The ſublimate, triturated a long time in a mortar with hot diſtilled water, diſſolved, and paſſed through a filter. To the filtrated liquor ſome fixed alkali being added, a precipitate was formed, which being well waſhed and dried, was ready melted by fire into a maſs reſembling porcelain. The ſame excellent and accurate chemiſt produced the ſame effects upon this ſtone by ſubſtituting inſtead of the vitriolic acid, the nitrous, marine, phoſphoric, or the concentrated acetous acids.

Further experiments on fluors have been made by Mr. Scheele, an account of which is given in the Swediſh Tranſactions for the year 1771; and from thence an abſtract in Engliſh is publiſhed in a pamphlet, called " An eaſy Method of Aſſaying and Claſſing " Mineral Subſtances, by John Reinhold Forſter, F. R. S."

Mr. Scheele obſerved upon diſtilling a mixture of fluor with oil of vitriol, that the fumes which aroſe corroded the glaſs veſſels, and formed a cruſt upon the water contained in the receiver, which cruſt gradually became thicker during the operation. The water alſo in the receiver was found, on examination, to contain a conſiderable quantity of a *new acid,* diſengaged from the ſpar by the oil of vitriol. The cruſt formed by the fumes acting upon the water of the receiver, was not ſoluble in acids, but was diſſolved by *oleum tartari per deliquium,* with which it formed a gelatinous ſubſtance. It was not fuſible by fire without addition; but when mixed with fixed alkali was vitrified. This vitrified ſubſtance being melted with a large portion of fixed alkali, deliqueſced, and afforded a precipitate upon adding to it an acid. Mr. Scheele concludes from theſe experiments, that the cruſt thus formed from the fumes uniting with water, is a true *flinty ſubſtance,* and that flints, therefore, conſiſt of this new acid of fluors united with water. From other experiments he is led to conclude, that the earth, which is united with this new acid in the fluors, is of the calcareous kind: for upon lixiviating with water the maſs that remained after the diſtillation of fluor with oil of vitriol, and

But the word flux is generally uſed to ſignify certain ſaline matters, which facilitate the fuſion of ores, and other

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adding ſalt of tartar, a calcareous earth (he ſays) was precipitated. Further, the acid of the fluor which had paſſed over into the receiver and mixed with the water, being added to lime-water, a white powder was precipitated, which though not in the form of cryſtals, was found to poſſeſs all the properties of the original fluor. This regenerated fluor being diſtilled with oil of vitriol, formed the ſame kind of cruſt on the ſurface of the water in the receiver. When alkohol, oil of olives, or oil of vitriol, were put into the receiver inſtead of water, no cruſt was formed. The ſame kind of cruſt was formed, when inſtead of oil of vitriol, the nitrous or marine acids were diſtilled with the fluor. By theſe two laſt mentioned acids the fluor could be diſſolved. Upon adding to the ſolution a mild volatile or fixed alkali, a powder was precipitated; and upon adding to the ſame ſolution ſome vitriolic acid, a gypſeous powder was precipitated.

The calcareous baſis was likewiſe ſeparated by mixing with one part of the fluor four parts of fixed alkali, melting this mixture, and lixiviating the fuſed maſs in water; by which means the calcareous earth of the fluor was precipitated, and a ſaline compound remained in the water, conſiſting of the acid of the fluor united with the fixed alkali.

Mr. Scheele examined the acid of the fluor, which though not diſtinguiſhable in ſmell from marine acid, differed materially in this reſpect, that the former acid, united with a calcareous earth, forms a ſolid ſubſtance; while the latter is known to form with that earth a very deliqueſcent ſalt. When the acid of fluor was diſtilled with a gentle heat, the ſtronger part of the acid, which did not come over till towards the end of the diſtillation, formed a cruſt with the more watery part that had paſſed firſt, and alſo corroded the glaſs veſſels. Upon mixing the acid of fluor with a fixed alkali, a gelatinous ſubſtance was produced, from which, by adding lime-water, a regenerated fluor was precipitated. This acid did alſo form gelatinous ſubſtances, when united with volatile alkali, magneſia, and earth of alum; But when ſaturated with lime-water, a regenerated fluor was precipitated. The powers of this acid on metallic ſubſtances were next examined. *Gold* was not affected by the acid of fluor, either alone or mixed with ſpirit of nitre. *Silver*, *quickſilver*, and *lead*, were not acted upon. *Copper* was partly diſſolved. *Iron* was acted upon violently; and the fumes, which aroſe during the ſolution, were inflammable. *Tin* was not acted upon; but its calx was diſſolved. *Biſmuth*, *cobalt*, and *regulus* of *antimony* were not diſſolved by this acid. *Zinc* was diſſolved in the ſame manner as iron. This acid occaſioned a precipitation in the ſolutions of ſilver and quickſilver in nitrous acid. It did not precipitate a ſolution of corroſive ſublimate, nor a ſolution of lead in nitrous acid.

matters which are difficultly fuſible in eſſays and reductions of ores. Fixed alkalis, nitre, borax, tartar, and common ſalt, are the ſaline matters of which fluxes are generally compoſed. But the word *flux* is more particularly applied to mixtures of different proportions of only nitre and tartar; and theſe fluxes are called by particular names, according to the proportions of theſe ingredients, as we ſhall ſee in the following articles.

FLUX (WHITE). White flux is made with equal parts of nitre and of tartar detonated together, by which they are alkaliſed. The reſiduum of this detonation is an alkali compoſed of the alkalis of the nitre and of the tartar, both which are abſolutely of the ſame nature. As the proportion of nitre in this mixture is more than is ſufficient to conſume entirely all the inflammable matter of the tartar, the alkali remaining after the detonation is perfectly white, and is therefore called *white flux*; and as this alkali is made very quickly, it is alſo called *extemporaneous alkali.* When a ſmall quantity only of white flux is made, as a few ounces, for inſtance, ſome nitre always remains undecompoſed, and a little of the inflammable principle of the tartar, which gives a red or even a black color to ſome part of the flux: but this does not happen when a large quantity of white is made flux; becauſe then the heat is much greater. This ſmall quantity of undecompoſed nitre and tartar which remains in white flux is not hurtful in moſt of the metallic fuſions in which this flux is employed: but if the flux be required perfectly pure, it might eaſily be diſengaged from thoſe extraneous matters by a long and ſtrong calcination, without fuſion. *See* CALCINATION.

FLUX (CRUDE). By crude flux is meant the mixture of nitre and tartar in any proportions, without detonation. Thus the mixture of equal parts of the two ſalts uſed in the preparation of the white flux, or the mixture of one part of nitre and two parts of tartar for the preparation of the black flux, are each of them a crude flux before detonation. It has alſo been called *white flux*, from its color; but this might occaſion it to be confounded with the white flux above deſcribed. The name, therefore, of crude flux is more convenient.

Crude flux is detonated and alkaliſed during the reductions and fuſions in which it is employed, and is then changed into white or black flux, according to the proportions of which it is compoſed. This detonation produces good effects in theſe fuſions and reductions, if the ſwelling and extravaſation of the detonating matters be guarded againſt. Accordingly, crude flux may be employed ſucceſsfully in many operations; as, for inſtance, in the ordinary operation for procuring the regulus of antimony.

FLUX (BLACK *or* REDUCING). Black flux is produced from the mixture of two parts of tartar and one part of nitre detonated together. As the quantity of nitre which enters into the compoſition of this flux is not ſufficient to conſume all the inflammable matter of the tartar, the alkali which remains after the detonation contains much black matter, of the nature of coal, and is therefore called *black flux.*

This flux is deſignedly ſo prepared, that it ſhall contain a certain quantity of inflammable matter; for it is thereby capable not only of facilitating the fuſion of metallic earths like the white flux, but alſo of reviving theſe metals by its phlogiſton. From this property it is alſo called reducing flux; the black flux, therefore, or crude flux made with ſuch proportions of the ingredients as to be convertible into black flux, ought always to be uſed when metallic matters are at once to be fuſed and reduced, or even when deſtructible metals are to be fuſed, as theſe require a continual ſupply of phlogiſton to prevent their calcination. *See* NITRE, REDUCTION, *and* TARTAR.

FORGE. An ordinary forge is nothing but a pair of bellows, the nozzle of which is directed upon a ſmooth area, on which coals are placed. The nozzle of a pair of bellows may be alſo directed to the bottom of any furnace, to excite the combuſtion of the coals placed there, by which a kind of forge is formed. In laboratories, there is generally a ſmall furnace conſiſting of one cylindrical piece, open at top, which has at its lower ſide a hole for receiving the nozzle of a double bellows. This kind of forge-furnace is very convenient for fuſions, as the operation is quickly performed, and with few coals. In its lower part, two inches above the hole for receiving the nozzle of the bellows, may be placed an iron plate of the ſame diameter, ſupported upon two horizontal bars, and pierced near its circumference with four holes diametrically oppoſite to each other. By this diſpoſition, the wind of the bellows, puſhed forcibly under this plate, enters at theſe four holes; and thus the heat of the fire is equally diſtributed, and the crucible in the furnace is equally ſurrounded by it. This contrivance is uſed in the forge-furnaces for melting copper, with this difference only, that theſe furnaces are ſquare, which is a matter of no conſequence.

As the wind of bellows ſtrongly and rapidly excites the action of the fire, a forge is very convenient when a great heat is to be applied quickly: but it is not ſuitable when the heat is to be gradually encreaſed.

The forge or blaſt of bellows, is uſed in ſeveral operations in ſmall; as to fuſe ſalts, metals, ores, &c. It is alſo much uſed in works in the great, which require ſtrong heat, without much management, and chiefly in the ſmelting of ores, and fuſion of metallic matters.

FRITT. Fritt is a mixture of ſeveral ſubſtances intended to be fuſed together for the purpoſe of making glaſs. After theſe ſubſtances have been mixed together, they are generally expoſed during a certain time to a more or leſs ſtrong heat, which is, however, incapable of compleatly fuſing them. The intention of this operation is either to effect a ſlight union betwixt theſe matters, or to free them more perfectly from any inflammable or extraneous matter, by this calcination. *See* VITRIFICATION.

FRUITS. *(h)*

(h) FRUITS are conſidered only as *coloring materials* in this article, the greateſt part of which is extracted from a note of Dr. Lewis to his Tranſlation of Neuman. The red juices of fruits, as of *currants*, *mulberries*, *elder berries*, *morello* and *black cherries*, when inſpiſſated and dried, may be again diſſolved in water, to which they give nearly the ſame red color as they do when freſh. Rectified ſpirit extracts the tinging particles, and acquires a brighter color than the watery ſolution: becauſe much of the mucilage is left undiſſolved by the former. The red ſolutions and the juices are ſometimes made dull, and ſometimes more florid, by acids, and are generally rendered purpliſh by alkalis. The colors of theſe juices are generally periſhable. They are not deſtructible by the fermentation of the liquors; but they quickly decay when the juice is ſpread thinly on any ſubſtance, and dried in open air. The bright lively reds are ſooneſt changed. The dark, dull red ſtain of the black cherry is conſiderably durable. The bright red fruit of the *opuntia* or *prickly pear* is an exception to the above rule; as it gives, according to Labat, a beautiful red dye. The ripe berries of *buckthorn* ſtain paper of a green color. From theſe is prepared the ſubſtance called *ſap-green*, which is a pigment ſufficiently durable, ſoluble in water, but not miſcible with oil. The ſame berries dried whilſt green, and macerated in alum-water, are ſaid to yield a yellow pigment; and when they have grown over-ripe, a purple

FULIGINOSITY. By this word is meant ſoot, or the black matter which accompanies the flame of oils and of oily ſubſtances. *See* Soot.

FULMINATION. Fulmination is the ſudden and violent exploſion and inflammation of certain bodies, which are therefore called *fulminating*. Such are the exploſions of fulminating powder and of fulminating gold. The exploſion of theſe matters is called *fulmination*, from the noiſe accompanying it, by which it reſembles thunder.

FURNACE. Furnaces are chemical inſtruments uſed for containing combuſtible matters, by the burning of which the heat requiſite for operations is procured; and alſo for containing the ſubſtances themſelves to which the heat ought to be applied.

As chemiſts require for different operations all the poſſible degrees of heat, from the weakeſt to the ſtrongeſt, and as the form of the furnaces contributes greatly, as we ſhall ſee, to produce the different degrees of heat; they have contrived many furnaces of different forms and conſtructions; but all theſe furnaces may be reduced to a ſmall number of general diſpoſitions, which we ſhall now deſcribe.

The *ſimple furnace* is a kind of hollow tower, cylindrical or priſmatical, with two doors or principal openings; the one below, called the *door of the aſh-hole*; and the other immediately above this, called the *door of the fire-place*. Betwixt theſe two doors a grate is placed horizontally acroſs the interior part of the furnace, dividing the whole cavity of the furnace into two parts; the lower part is called the *aſh-hole*, becauſe it receives the aſhes which fall from the

pigment. Woollen cloth, prepared with alum and tartar, receives, on being boiled with the berries, a periſhable yellow dye. The *French berries*, or *graine d'Avignon*, one of the moſt periſhable yellow dyes, is a berry of the ſpecies of buckthorn. It is ſaid that the berry of the *heliotropium tricoccum* ſtains paper of a green color; and that this green is ſoon changed to a blue; that the common blue paper receives its color from this juice; and that the red rags called *turnſol*, employed for coloring wines and other liquors, are tinctured by the ſame juice turned red by acids. Mr. Niſſole ſays, that the coloring juice is obtained, not from the berries, but from the tops of the plant. The Dutch are ſaid to prepare theſe rags from other materials, of which archil is a principal one.

The ſeeds of ſome plants, as of *peony*, are covered with a fine ſhining red membrane. The pellicles of the ſeeds of an American tree afford the red maſſes called *annotto*, *orlean*, and *roucou*. *See* Annotto.

fire-place, The door of the aſh-hole gives admittance to the air neceſſary for maintaining the fire within the furnace. The upper cavity of the furnace is called the *fire-place*, becauſe it contains the combuſtible matters. Through the door of the fire-place freſh fuel is to be introduced, to ſupply the place of what is conſumed.

The ſimple furnace, ſimilar to that uſed in kitchens, is ſufficient for many chemical operations. In the fire-place, amidſt the coals, crucibles may be placed for the fuſion of fuſible matters; ſuch as lead, tin, biſmuth, &c. or for the calcination of matters which require but little heat for their calcination; ſuch as the alkali for making Pruſſian blue, bezoar mineral, &c.

On this furnace may alſo be placed baſons for evaporations, alembics for diſtilling in the water-bath, pots filled with ſand for digeſtions and diſtillations to be performed by means of a ſand-bath and a gentle heat, either with alembics or with retorts.

As ſeveral of the operations made with this furnace are of long duration, and as the furnace requires a continual ſupply of fuel; chemiſts have contrived to adapt to it a magazine of coals in form of a hollow tower, cloſed in its upper part, and ſo diſpoſed, that while the coal of the fire-place is conſumed, that of the tower falls down and ſupplies its place. The furnace thus diſpoſed is called an *athanor*, or the *furnace of ſluggards*. *See* ATHANOR. *See* PLATE II. *fig*. 2.

The *lamp-furnace* is a kind of athanor, in which the heat is produced and maintained by the flame of a lamp introduced within it. This furnace has evidently no occaſion for an aſh-hole, a grate, or a fire-place. It has only one opening below, through which the lamp is introduced, and a kind of ſmall chimney made in its upper and lateral part, for circulation of air, to keep up the flame of the lamp, and to give vent to the ſmoke. This furnace is very convenient for diſtillations which require little heat. A water-bath or ſand-bath may be fitted to it. It is particularly uſeful for digeſtions.

The *reverberatory furnace* is the ſimple furnace, the fire-place of which is covered with a piece of the ſame diameter and form as the furnace, which is generally cylindrical. This piece is croſſed in its lower part by two bars of iron placed horizontally and parallel to each other, and at its upper edge it has a ſemi-circular cut. This piece conſequently forms a third cavity, which is called the *Laboratory*, becauſe it is intended to receive the retorts containing the matter to be diſtilled. The ſemi-circular cut is made to give paſſage to the neck of the retort, which, as we have ſaid under the article DISTILLATION, ought to be inclined at an angle of 45 degrees. The uſe of the two bars at the bottom of the laboratory is to ſupport the veſſel placed there.

Above the piece we have now deſcribed is a fourth piece placed, the form of which is that of a ſpherical cap, or of an inverted dome: it is accordingly called the *dome*. This dome has an equal diameter to the other piece to which it is to be fitted; and in its lower edge it has a ſemi-circular cut, which correſponds with the ſimilar cut of the lower piece; and theſe together form a circular opening: the dome has in its top another opening or ſhort tube, through which the air contained in the furnace paſſes, and is a kind of chimney.

The uſe of the dome is to keep up the heat all around the retort which is placed in the furnace, and to apply a certain degree of heat to the upper part or vault of the retort, by reflecting or reverberating it: hence it is called a *reverberatory*. By this diſpoſition the vapors which riſe in the retort are determined more efficaciouſly to paſs through its neck. We may judge after this deſcription, that reverberatory furnaces are only uſed for diſtillations with a retort, in which a certain degree of heat is neceſſary.

Diſtillation may be performed in reverberatory furnaces, either in naked fire, by placing the retort immediately upon the bars, or in a ſand-bath, by placing upon theſe ſame bars an iron veſſel, in the upper edge of which is a ſemi-circular cut. Into this iron veſſel is put fine ſand to the thickneſs of one or two fingers; then the retort is to be placed in it; and, laſtly, it is to be filled with ſand up to the arch of the retort. If the heat be required to be of a certain ſtrength, the iron veſſel muſt have a diameter ſo much leſs than the internal part of the furnace, that an empty ſpace of about the thickneſs of a finger ſhall be left betwixt them, excepting on the ſide where the neck of the retort is; and there the hollow cuts of the furnace and iron veſſel that correſpond to each other ought to join exactly. *See* PLATE II. *fig.* 3.

The *melting furnace*, or wind furnace, is intended to produce the greateſt degree of heat that can be excited without bellows. This furnace ought to be ſo conſtructed, that a current of air ſhall conſtantly paſs through the fire-place; and the more ſtrongly and rapidly this air paſſes, the more intenſe will be the heat in the furnace.

The chief method for producing this effect is, to leave in the upper part of the furnace a ſpace cloſe on every ſide, excepting above and below; becauſe the air contained in this cavity being rarefied and expelled by the heat produced by the fuel burning in the furnace, a vacuum is here formed, which the external air neceſſarily tends to occupy from its gravity.

This being eſtabliſhed, the furnace ought evidently to be ſo diſpoſed that the external air ſhall be obliged to enter at the aſh-hole, and to paſs through the fire-place, to fill the vacuum which is continually forming both in the internal part of the furnace and in its upper cavity.

We ought to obſerve, that the column of air which correſponds with the upper part of the furnace, being a little ſhorter, and conſequently lighter, than the column which correſponds with the lower part, the air appears naturally determined to enter at the bottom, and to go out at the top of the furnace; ſo that if this furnace was a hollow cylinder, the lower and upper mouths of which were equal, and if the fire-place was in the middle, the air would probably paſs through it from bottom to top; but this difference of the two columns being almoſt infinitely ſmall, the velocity of the current of air would be as ſmall: but if, inſtead of this diſpoſition, the furnace be contracted in its upper part, and if it be made to become a tube of leſs diameter, then the rarefied air is obliged conſiderably to accelerate its courſe in paſſing through a ſtraiter ſpace. and thereby overcomes more eaſily the preſſure of the ſuperior air: hence the air introduced through the lower part of the furnace, in order to fill the vacuum which is continually forming in its upper part, paſſes ſo much more rapidly through the fire-place as it finds leſs obſtacle above; and conſequently this diſpoſition of the furnace neceſſarily determines a ſtrong and rapid current of air to paſs through it, from the bottom to the top.

From what has been ſaid we may eaſily perceive, that the more the ſpace or air is rarefied in the upper part of the melting furnace, the ſtronger and more rapid is the external current of air which is obliged to enter the furnace to fill up this vacuum; and conſequently the more intenſely the coals muſt burn. Hence theſe furnaces produce ſo much more heat, as the tube which is at their upper part, called the *tube of aſpiration*, is longer. But we muſt obſerve, that although the activity of this furnace is owing in a great meaſure to the contraction in its upper part or to its tube; nevertheleſs a too great contraction of the tube would be very inconvenient, becauſe the air rarefied, and obliged to go out at the upper part, can only acquire a certain determinate velocity: whence it follows, that if this tube, through which the rarefied air is to go out, were ſo ſtrait that this air could not paſs, unleſs it had a greater velocity than it is capable of acquiring, then the air, finding an obſtacle in its way, would be retarded in its progreſs; and conſequently too great ſtraitneſs in the tube impedes rather than facilitates the courſe of the air: accordingly, I have found by experience, that a melting furnace to which too ſtrait a tube, however long, has been adapted, produces little effect, compared with that cauſed by a tube of ſufficient diameter.

Hence the diameter of the tube muſt have a certain relation to the capacity of the furnace, and to the door of the aſh-hole. I have found that the diameter of the tube ought to be to the diameter of the furnace as 2 to 3 nearly, particularly when the tube is long enough. The opening at the bottom of the furnace may be equal in width to the body of the furnace, or it may be contracted, if the air be required to ſtrike the fire with more force and rapidity. After all theſe principles, we now proceed to the conſtruction of a good melting furnace. The body of this furnace does not differ from that of a ſimple furnace, except that it is, or may be open, or almoſt entirely open below, and ſupported upon feet, or a kind of tripod, which ſerves as an aſh-hole. An elliptical form is generally given to it, with intention to concentrate the heat *(h)*. The upper part of this furnace is terminated by a dome higher than that of the reverberatory furnace, called the *cap*. This cap has two openings, one of which is placed laterally and in the front; it ought to be large, and to be capable of being cloſely ſhut by a door: the other is at the top, and ought to be a tube of a convenient diameter, upon which other tubes of indeterminate length are adjuſted.

(h) The inequality of the ſurface of the ſides of the furnace would prevent any advantage from the elliptical form, even if heat were ſuppoſed to diffuſe itſelf, like light, only in right lines, and to be thereby capable of concentration by reflection; a ſuppoſition, however, which is not proved.

This furnace has no laboratory, or rather its laboratory is the fire-place itſelf; for the matters to which the heat is to be applied are placed in the fire-place, and ſurrounded by the burning coals.

The melting furnace may have a door to the fire-place; but this door ought to be kept ſhut during the operations. It only ſerves for the more convenient examination of the condition of the crucibles or other matters placed in the furnace, and not for the introduction of freſh fuel, for which purpoſe the door of the cap is intended. This latter door ought to be very large, that a conſiderable quantity of coal may be thrown in at once. The reaſon why this door is preferable to the door of the fire-place for the introduction of the fuel is, that the current of air may not be diſturbed in its direction; and therefore the lateral door ought to be kept open as little as poſſible.

When the internal diameter of ſuch a furnace is 12 or 15 inches, when the diameter of the tube is 8 or 9 inches, and its height 18 or 20 feet, and when the furnace is well ſupplied with fuel, an extreme heat is produced: in leſs than an hour the fire will be white and dazzling, like the ſun; its heat will be equal to the ſtrongeſt degree of heat in a glaſs-houſe furnace. In leſs than two hours may be melted whatever is fuſible in furnaces *(i)*. The hotteſt part of this furnace is 4 or 6 inches above the grate.

Chemiſts generally believe that the power of a melting furnace is greatly increaſed by a wide and high aſh-hole, or by bringing the air which is to enter it through a long pipe from without the houſe in which the furnace ſtands: but theſe advantages are either imaginary, or only relative to the vacuum formed in the upper part of the furnace. If indeed a furnace be ſo placed that the opening of its aſh-hole ſhall be fitted to the mouth of a great cavity; as to a cave, for inſtance, in the roof of which a hole is made, into which this furnace is to be fitted; and if this cave has no other opening than through the bottom of the furnace; then a very ſtrong current of air will paſs from the cave acroſs the furnace, although the furnace had neither cap

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(i) Moſt fuſible ſubſtances may be fuſed in a much leſs time: nevertheleſs we find from M. D'Arcet's Memoir concerning the effects of a violent and long-continued heat, that by prolonging the action of fire, he had been able to vitrify ſubſtances which had reſiſted the moſt violent fires continued only during a ſhorter time.

nor tube: but we muſt obſerve, that this current of air will always be ſtronger if the furnace is provided with a dome and tube; and ſecondly, if the air be determined to paſs from the cave acroſs the furnace, even without dome or tube, this muſt proceed only from the heat of the furnace rarefying the ambient air, by which the more condenſed air of the cave is determined to paſs through the furnace to ſupply the place of this rarefied air. In this caſe, the chamber in which the furnace is placed ſerves inſtead of the dome and tube. This happens in a glaſs-houſe furnace. Theſe furnaces are built upon ſubterranean vaults, which ſerve as aſh-holes. The internal capacity of theſe furnaces is very great, and is occupied only partly by the combuſtible matters, and by the pots containing the glaſs: hence the air of the aſh-hole is continually introduced there to fill this empty ſpace: beſides, the heat is always very great in the domes under which the furnaces are built; the contained air is therefore continually rarefied; ſo that they ſerve as the domes and tubes of furnaces to draw the air from the vaults.

The pipe which is ſometimes fitted to the aſh-hole of melting furnaces does not contribute to the draught of the furnace, excepting the laboratory in which the furnace ſtands be ſmall and confined: for then the air of this laboratory, being ſoon heated and rarefied, becomes leſs proper for exciting fire than the colder external air which the pipe ſupplies. *See* PLATE II. *fig.* 4. 5. 6. 7. 8. & *fig.* 18.

The furnace called the *eſſay* or *cupelling furnace* is of a priſmatic quadrangular figure, and is chiefly uſed to make eſſays of the value of ſilver, or of ſilver ores. This furnace is compoſed of an aſh-hole, a fire-place, and an upper part which terminates it above, like a quadrangular truncated pyramid. The fire-place and aſh-hole are not, properly ſpeaking, ſeparated from each other, becauſe this furnace has no grate; hence the coals in this furnace fall to the bottom: in the lower part of the furnace are three ſmall doors, two in the ſides, and one in the front: above this latter door is a fourth door, placed like that of the fire-place of a ſimple furnace; and at the bottom of this door are two iron bars, placed within the furnace horizontally and parallel to each other. Theſe bars are intended to ſupport a muffle, the mouth of which correſponds exactly to the laſt mentioned door. In this muffle the cupels and veſſels capable of containing the matter to be heated are to be placed.

The top of this furnace is truncated, and forms a pretty large aperture, through which the fuel is to be introduced. Some of theſe furnaces have a ſmall hole in the front of this upper part, through which an iron rod is introduced to puſh the coals down, and which alſo ſerves to ſhew the ſtate of the fire. In ſome of theſe furnaces the upper part is terminated by a ſhort tube; which on ſome occaſions is convenient; for although the internal capacity of this furnace, including its upper part, makes a ſufficient draught for theſe operations, a greater heat may poſſibly be required, and this is effected by adapting a tube to this furnace. *See* ESSAYS, *and* PLATE II. *fig.* 1.

Some operations, which muſt be made either in a muffle or in a reverberatory furnace, require the ſtrongeſt melting heat. The diſtillation of Kunckel's phoſphorus, for inſtance, requires a heat much ſuperior to that of ordinary diſtillations. Eſſays alſo of porcelain and vitrification, which ought to be done very cleanly, and therefore under a muffle, require a very violent heat, which cannot be procured in an ordinary eſſay furnace. In theſe caſes a tube may be fitted to the diſtilling or to the eſſay-furnaces, like that of the melting furnace; and thus as ſtrong a heat as is wanted may be procured. *See* PHOSPHORUS, PORCELAIN, VITRIFICATION. *(l)*.

Chemiſts have contrived many other furnaces, and ſome very complicated, for particular purpoſes; but they are moſtly embarraſſing, ill-contrived, and even uſeleſs: for by the furnaces above deſcribed an able operator may perform perfectly well every chemical operation.

All theſe furnaces may be either portable, and compoſed of baked earth hooped with iron rings; or covered with iron plates, if they are intended to be more durable; or they may be fixed and ſtationary, and made of bricks and tiles. This depends on the ſize and diſpoſition of the laboratory.

The matter of all chemical furnaces is always a clay, which ought to be of a good quality. Common clays do well enough for furnaces that are not intended to ſuſtain very violent heats, by which furnaces are apt to be cracked d deſtroyed, even before the operation is finiſhed, unleſs

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(l) *See* PLATE II. where ſeveral furnaces are repreſented, and the deſcriptions annexed; in which the proper compoſitions for lining the inſides of furnaces made of plated iron, and the methods of applying them, are related

they are made of the moſt pure and refractory clay. *See the clays moſt proper for this purpoſe under the article* Clay.

In theſe furnaces no iron bars or ſupports ought to be uſed, as that metal is very quickly melted, calcined, and deſtroyed. All the ſupports within theſe kinds of furnaces ought to be of the ſame clay of which the furnace conſiſts. As the heat is much leſs in the tube than in the body of the furnace, this tube is frequently made of iron plates, excepting its lower part, which ought always to be made of clay. Theſe tubes of iron plate have many advantages, as they are light and manageable; but they have a great inconvenience, which is, that their inner ſurfaces are ſubject to calcine; hence when much flame paſſes through them, ſcales fly off from the iron with noiſe; which falling upon the crucibles and muffles, diſpoſe them to vitrify, becauſe iron is a powerful flux to clay. The whole tube ought therefore to be made of clay.

When the tube is long, it ought to be ſtrengthened by iron rings and hooks; but theſe ought to be ſo arranged that the tube may be lengthened and ſhortened, according as the greater or leſs heat may diſpoſe it; otherwiſe it might crack.

The furnaces deſcribed in this article are employed, and are neceſſary, for the ſeveral operations of chemiſtry. Many of them are alſo uſed in the arts, in manufactures, and in works in the great: ſuch are the furnaces for glaſs, pottery, porcelain, and for ſmelting of ores. What is peculiar to any of theſe furnaces may be found under the article of the art in which it is employed. In other reſpects their ſtructure is conformable to the general principles eſtabliſhed in the preſent article.

FUSIBILITY. Fuſibility is a quality which renders bodies ſuſceptible of becoming fluid, when expoſed to a certain degree of heat. Fuſibility is the reverſe of the refractory quality; ſo that the leſs the heat is which is requiſite for the fuſion of any ſubſtance, the more fuſible it is.

Bodies differ much from each other as to their degrees of fuſibility. Some of them, as air and mercury, are ſo fuſible that the heat of the atmoſphere is always ſufficient to keep them fluid: others, as ſome oils and water, which are naturally ſolid with the degree of cold marked 0 in Reaumur's thermometer, are preſently melted when they are expoſed to a greater heat: other ſubſtances again, as lead, tin, biſmuth, &c. are habitually ſolid in the greateſt natural heats; but are fuſible with a degree of heat leſs than is requiſite to make them red: and laſtly, others are not fuſible till they become red, and even white, by heat: ſuch are ſilver, gold, copper, iron, glaſs, &c.

As the fuſion of a body is cauſed by the interpoſition of fire betwixt its integrant parts, by which their adheſion is deſtroyed, we cannot conceive any other cauſe of the greater or leſs fuſibility than a more or leſs intimate contact, and a more or leſs ſtrong adheſion of the integrant parts of different bodies; which are diſpoſitions depending on the figure of theſe parts. *See* HARDNESS *and* FLUIDITY.

FUSION. Fuſion is the ſtate of a body rendered fluid by fire. *See* FLUIDITY *and* FUSIBILITY.

END of the FIRST VOLUME.